CHARLES UNIVERSITY

FACULTY OF SOCIAL SCIENCES

Institute of Economic Studies

Bachelor thesis

2019 **Lucie Šanderová**

CHARLES UNIVERSITY

FACULTY OF SOCIAL SCIENCES

Institute of Economic Studies

Lucie Šanderová

Analysis of Health Quality Indicators in the Framework of Sustainable Development Goals

Bachelor thesis

Prague 2019

Author: Lucie Šanderová

Supervisor: doc. Ing. Tomáš Cahlík, CSc.

Academic year: 2018/2019

Bibliographic note

ŠANDEROVÁ, Lucie. *Analysis of Health Quality Indicators in the Framework of Sustainable Development Goals.* Prague, 2019. 62 pages. Bachelor thesis (Bc). Charles University, Faculty of Social Sciences, Institute of Economic Studies. Supervisor doc. Ing. Tomáš Cahlík, CSc.

Abstract

This thesis studies two indicators of good health and well-being embedded in the United Nations 2030 Agenda for Sustainable Development; suicide mortality rate and harmful use of alcohol. Firstly, socio-economic determinants of suicide mortality rate and alcohol per capita consumption in countries of the European Union are analysed. As an econometric approach, panel data methods are utilized. Among selected economic and socio-demographic variables, suicide mortality rate is found sensitive to unemployment rate, whilst economic growth, fertility rate and female labour participation rate are concluded not have a significant impact. Model of alcohol consumption confirms relatively higher sensitivity to changing income than to alcohol price level. First differencing estimation produces income and price elasticity within range of prior estimates. Secondly, an ARIMA forecast is performed for the EU and its member states to assess current prospects of attaining targets corresponding to the two health quality indicators in question by year 2030. For the EU collectively, forecasts suggest rather favourable development, although considerable disparities are present among individual member states.

Abstrakt

Tato bakalářská práce se zabývá dvěma indikátory zdraví a kvalitního života zakotvenými v Agendě OSN pro udržitelný rozvoj 2030; mírou úmrtnosti na sebevraždy a škodlivým užíváním alkoholu. Nejprve jsou analyzovány socioekonomické činitele působící na míru úmrtnosti na sebevraždy a spotřebu alkoholu na osobu v zemích Evropské unie. Ekonometrický přístup využívá metod panelových dat. Z vybraných ekonomických a sociodemografických činitelů je míra úmrtnosti na sebevraždy citlivá na míru nezaměstnanosti, zatímco pro ekonomický růst, míru plodnosti a míru účasti žen na trhu práce nebyl zjištěn statisticky významný efekt. Model konzumace alkoholu potvrzuje relativně vyšší citlivost vůči měnícím se příjmům nežli měnící se cenové hladině alkoholu. Příjmová a cenová elasticita získané v odhadu prvních diferencí odpovídají rozsahu dřívějších odhadů. Dále je provedena ARIMA predikce pro zhodnocení současných vyhlídek dosažení cílů příslušících ke dvěma zkoumaným indikátorům zdraví a kvalitního života v Evropské unii a jejích členských státech do roku 2030. Pro EU jako celek vykazují predikce poměrně příznivý vývoj, mezi členskými státy jsou však patrny značné rozdíly.

Keywords

Sustainable Development Goals, Suicide mortality rate, Harmful use of alcohol, European Union, Panel data analysis, ARIMA forecast

Klíčová slova

Cíle udržitelného rozvoje, Míra úmrtnosti na sebevraždy, Škodlivé užívání alkoholu, Evropská unie, Analýza panelových dat, ARIMA predikce

Range of thesis: 62 718

Declaration of Authorship

1. The author hereby declares that she compiled this thesis independently, using the listed resources and literature only.

2. The author hereby declares that all the sources and literature used have been properly cited.

3. The author hereby declares that the thesis has not been used to obtain a different or the same degree.

Prague, May 7, 2019 Lucie Šanderová

Acknowledgements

I would like to express my sincere gratitude to doc. Ing. Tomáš Cahlík, CSc. for his guidance, valuable insights and professional advice in the process of writing this Bachelor thesis.

Institute of Economic Studies
Bachelor thesis propsal

Author: Lucie Šanderová

Supervisor: doc. Ing. Tomáš Cahlík, CSc.

Proposed topic: Analysis of Health Quality Indicators in the Framework of Sustainable Development Goals

Research question and motivation:

The Sustainable Development Goals (SDGs) are 17 global goals specified within the United Nations 2030 Agenda for Sustainable Development. Adopted at the United Nations General Assembly in September 2015, they build on the framework of Millennium Development Goals, aiming to reach further by addressing a wider scope of issues of societal and environmental character. Among other additions, the goal for good health and well-being newly targets prevention and treatment of substance abuse, reduction in the number of deaths from non-communicable diseases, and mental health promotion.

According to the World Health Organization European Region, Europe is facing the highest per capita alcohol consumption levels in the world. In addition, many of its countries are tackling high suicide rates. It is therefore relevant to examine to what extent these problems can be resolved within the time frame of SDGs in this region.

Contribution:

The aim of the thesis is to analyze current development and forecast future advancement in attaining healthy lives and well-being in countries of the European Union based on two health quality indicators established within the SDG framework: (1) Harmful use of alcohol, defined according to the national context as alcohol per capita consumption (aged 15 years and older) within a calendar year in liters of pure alcohol, and (2) Suicide mortality rate. The results of the analysis will allow for discussion on the achievability of the related targets and their connection.

Methodology:

Econometric analysis of panel data will be conducted. Eurostat, OECD and WHO data repositories will serve as the main data sources. The alcohol consumption analysis will be set on real per capita income and real alcohol price index, as employed by Nelson (2014). The model of suicide mortality rate will consist of economic and socio-demographic variables, following the approach of Andrés (2005). Such model presents a combination of two widely adopted viewpoints on the determinants of suicide proposed by Hamermesh and Soss (1974) and Durkheim (c1951).

Outline:

1. Introduction
2. Sustainable Development Goals
    - Overview of 17 Sustainable Development Goals
3. Theoretical background
4. Methodology
    - Panel data theory
5. Empirical model
6. Forecast model
7. Results and discussion
8. Conclusion

List of academic literature:

[1] DURKHEIM, Émile. *Suicide: a study in sociology*. New York: Free Press, c1951. ISBN 0-684-83632-7

[2] HAMERMESH, Daniel S., SOSS, Neal M. An Economic Theory of Suicide. *Journal of Political Economy* [online]. 1974, 82(1), 83-98 [cit. 2018-05-23]. ISSN 00223808. Available at: https://www.jstor.org/stable/1830901?seq=1#page_scan_tab_contents

[3] NELSON, Jon P. Alcohol Affordability and Alcohol Demand: Cross-Country Trends and Panel Data Estimates, 1975 to 2008. *Alcoholism, Clinical And Experimental Research* [online]. 2014, 38(4), 1167-1175 [cit. 2018-05-16]. ISSN 15300277. DOI: 10.1111/acer.12345. Available at: https://onlinelibrary.wiley.com/doi/pdf/10.1111/acer.12345

[4] RODRÍGUEZ ANDRÉS, Antonio. Income Inequality, Unemployment and Suicide: A Panel Data Analysis of 15 European Countries. *Applied Economics* [online]. 2005, 37(4), 439-451 [cit. 2018-05-23]. ISSN 00036846. DOI: 10.1080/0003684042000295304. Available at:

https://www.tandfonline.com/doi/full/10.1080/0003684042000295304
[5] UNITED NATIONS. *Transforming our world: the 2030 Agenda for Sustainable Development* [online]. New York: UN Publishing. 21 October 2015 [cit. 2018-05-22]. Available at:
http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E

Table of Contents

List of Abbreviations

ARIMA	Autoregressive Integrated Moving Average
AUT	Austria
BEL	Belgium
BGR	Bulgaria
CYP	Cyprus
CZE	Czech Republic
DEU	Germany
DNK	Denmark
ESP	Spain
EST	Estonia
EU	European Union
FD	First Differencing
FE	Fixed Effects
FIN	Finland
FRA	France
GBR	United Kingdom
GDP	Gross Domestic Product
GRC	Greece
HUN	Hungary
HRV	Croatia
IRL	Ireland
ITA	Italy
LTU	Lithuania
LUX	Luxembourg
LVA	Latvia
MDG	Millennium Development Goal
MLT	Malta
NLD	Netherlands
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares
POL	Poland
PRT	Portugal
RE	Random Effects
ROU	Romania
SDG	Sustainable Development Goal
SVK	Slovakia
SVN	Slovenia
SWE	Sweden
UN	United Nations
US	United States
WHO	World Health Organization

List of Figures

List of Tables

Introduction

Sustainable Development Goals (SDGs) are globally recognized goals established by the United Nations (UN) in the 2030 Agenda for Sustainable Development. Succeeding termination of the UN's Millennium Development Goals (MDGs) programme in 2015, SDGs constitute a further fifteen-year set of objectives aimed at ensuring prosperity for people and planet and attaining peace around the world. The 2030 Agenda encompasses a wide scope of societal and environmental concerns of sustainable development, establishing relevant targets to combat current challenges, prevent future setbacks and reach envisioned goals by year 2030 (United Nations, 2015b). Currently, Sustainable Development Goals are in relatively early stages of implementation. In view of the large span of matters in consideration and high ambition of the framework, it is relevant to examine what is the current standing of countries in terms of its fulfilment and determine where action should be focused.

Goal 3 of the 2030 Agenda seeks to secure healthy lives and foster well-being for everyone across all age groups (United Nations, 2015b). In this thesis, two indicators of progress upon this goal are analysed for member states of the European Union (EU); specifically, suicide mortality rate and harmful use of alcohol. Both these indicators represent new areas of attention in health matters compared to those covered by MDGs. The SDG framework proposes enhanced efforts in care for mental health and well-being, as well as prevention and treatment of substance abuse (United Nations, 2015a; United Nations, 2015b).

The aim of the thesis is to answer the following questions: What are the socio-economic determinants of healthy lives in the EU? Is the EU on the right path to achieve healthy lives by 2030? In examining determinants of suicide mortality rate and harmful use of alcohol, panel data analysis is utilized. This econometric method allows to control for country-specific and time-fixed effects. Model of suicide mortality rate follows the approach of Andrés (2005), combining economic and socio-demographic explanatory variables based upon the pioneering works of Durkheim (c1951) and Hamermesh and Soss (1974). Model of harmful use of alcohol inspects the effects of alcohol affordability on alcohol consumption as regarded by Nelson (2014), employing more recent data on a larger sample of countries. Moreover, an Autoregressive Integrated Moving Average (ARIMA) forecast is carried out on both country level and for the European Union as a whole in order to assess current prospects of completing the two corresponding SDG targets, assuming business as usual in the upcoming years.

The thesis begins by introducing the 2030 Agenda for Sustainable Development, with a deeper focus on suicide mortality rate and harmful use of alcohol. Recent development of the two health quality indicators in EU member states is briefly discussed. Next, literature review provides a summary of previous studies, facilitating selection of appropriate independent variables for the two econometric models. The following sections overview panel data theory and data used in empirical analysis. Further, hypotheses for both models are formulated, succeeded by interpretation of obtained regression results. Last chapter presents the ARIMA forecast method and discussion of forecasted progress in attaining healthy lives in the time horizon of Sustainable Development Goals. Key findings are summarized in Conclusion.

1. The 2030 Agenda for Sustainable Development

The 2030 Agenda for Sustainable Development was adopted by the General Assembly of the United Nations at its 70th convention on September 25th, 2015. The overarching aim of the United Nations' development plan is to secure prosperity and peace around the world. The Agenda is a vision for world development by year 2030 accepted by all 193 UN member states, balancing economic, social and environmental aspects of sustainability. Following the termination of the Millennium Development Goals programme in 2015, it expands the spectrum of objectives introduced by MDGs and aims at further progress in attainment of the ones previously sought. The 2030 Agenda presents 17 Sustainable Development Goals, as outlined in Table 1, along with 169 sub-targets, which specify the action necessary towards goal achievement.

The primary notion of the framework is fighting poverty (United Nations, 2015b). MDGs had set out to reduce extreme poverty rate between 1990 and 2015 by half. Succeeding the completion of this goal (United Nations, 2015a), SDGs aim at complete eradication of poverty. Moreover, it is targeted to resolve hunger, advance health quality, ensure full respect of human rights, and provide equal opportunities for everyone. The 2030 Agenda calls for peaceful, just societies. Further, it accentuates the importance of environmental protection and adoption of measures to combat climate change. Conscious management of natural resources is considered key in preserving social and economic prosperity into the future. Lastly, countries are requested to cooperate intensively on goal implementation and support regions with least favourable conditions (United Nations, 2015b).

In July 2017, the General Assembly of the United Nations adopted the 'Global indicator framework for the Sustainable Development Goals and targets of the 2030 Agenda for Sustainable Development'. Henceforth, one or more indicators are defined in relation to each target as a tool for unequivocal progress assessment (United Nations, 2017). Holden et al. (2017) argue, however, that as a result of the large scope of world development concerns SDGs cover, several goals contradict each other. Moreover, it is suggested that some goals are considerably vague in specification; especially those related to environmental protection lack quantifiability. This may result in ambiguous progress interpretation in spite of the introduction of respective indicators and may also decrease the accountability for completion of the 2030 Agenda. It is appealed upon individual countries by the UN (2015b) to recognize the challenges they are facing and take locally suited action to resolve them.

Table 1: Sustainable Development Goals

Goal 1	End poverty in all its forms everywhere
Goal 2	End hunger, achieve food security and improved nutrition and promote sustainable agriculture
Goal 3	Ensure healthy lives and promote well-being for all at all ages
Goal 4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
Goal 5	Achieve gender equality and empower all women and girls
Goal 6	Ensure availability and sustainable management of water and sanitation for all
Goal 7	Ensure access to affordable, reliable, sustainable and modern energy for all
Goal 8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
Goal 9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
Goal 10	Reduce inequality within and among countries
Goal 11	Make cities and human settlements inclusive, safe, resilient and sustainable
Goal 12	Ensure sustainable consumption and production patterns
Goal 13	Take urgent action to combat climate change and its impacts
Goal 14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development
Goal 15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
Goal 16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
Goal 17	Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development

Source: United Nations (2015b)

1.1 Goal 3: Good Health and Well-Being

According to the Millennium Development Goals Report 2015, between 1990 and 2013 maternal mortality ratio declined by 45 percent worldwide. Global under-five child mortality rate lowered from 90 to 43 deaths per 1 000 live births between 1990 and 2015 (United Nations, 2015a). Sustainable Development Goals largely build upon the ambition of the preceding MDGs regarding health. Firstly, they set out to decrease maternal mortality ratio below 70 deaths per 100 000 live births. Secondly, under-five child mortality shall be reduced to 25 or fewer deaths per 1 000 live births, and neonatal child mortality to 12 or fewer deaths per 1 000 live births. Similarly, the 2030 Agenda follows up in aiming at successful treatment and prevention of AIDS, malaria, and other communicable diseases. It is also targeted to achieve universal access to reproductive health care.

However, not only the scope of health goals has been expanded. The spectrum has been increased to cover the concerns of non-communicable diseases, mental health, substance abuse, injuries and deaths resulting from traffic accidents, as well as illnesses and deaths due to pollution, contamination and hazardous chemicals. Lastly, SDGs seek to ensure universal health coverage (United Nations, 2015b).

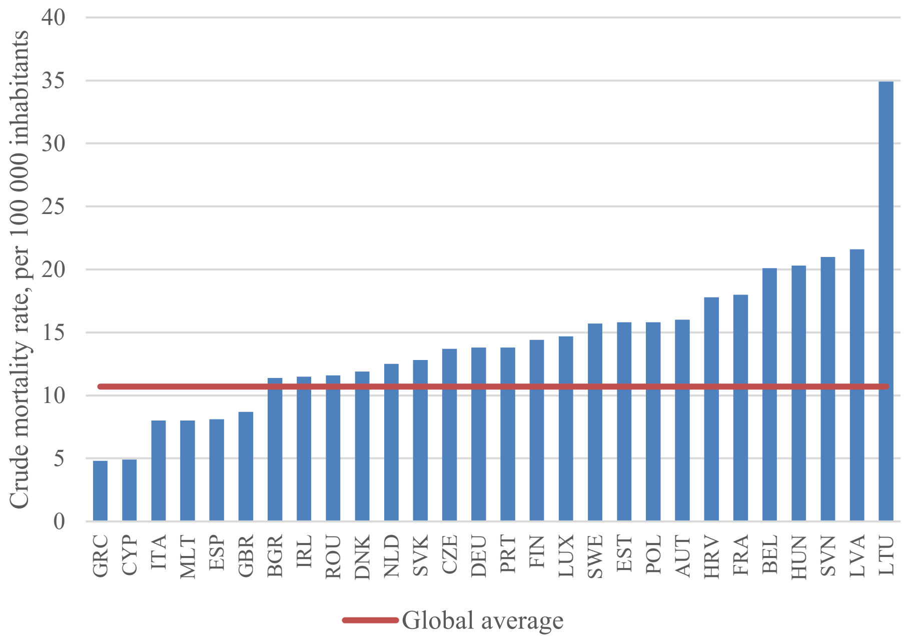
1.1.1 Suicide Mortality Rate

Target 3.4 of the 2030 Agenda for Sustainable Development states: 'By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being' (United Nations, 2015b). Suicide mortality rate serves as one of two indicators of its attainment, alongside mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease (United Nations, 2017). Suicide mortality rate is defined as 'number of suicide deaths in a year, divided by the population, and multiplied by 100 000' (UN Statistics Division, 2017).

According to the World Health Organization (WHO), globally, over 800 000 people lose their lives to suicide every year. Despite existing evidence that these deaths are largely preventable, many health care systems fail to give suicide prevention enough priority. Moreover, taboo and stigma surrounding suicide often hinders active search for help, which in turn therefore cannot be provided. Suicide deaths and suicide attempts have profound, long-lasting impact on the actors' families, friends and communities (WHO, 2014). In establishing effective suicide prevention programmes, WHO (2014) recommends that policy makers maintain a multisectoral perspective, as matters of suicide are not limited to the health sector but affect society as a whole.

Between 2000 and 2015, suicide and self-inflicted injury was the leading external cause of death in Europe, followed by death due to motor vehicle traffic accidents. Despite a substantial decrease in suicide mortality, it accounted for approximately 1.47% of all deaths in the region in 2015 (WHO Regional Office for Europe, 2018). Of the 28 EU member states, 22 state-level suicide rates remained above world average, as depicted in Figure 1. Notably, Lithuania's reported value exceeded world average more than threefold. At 34.9 deaths per 100 000 inhabitants, it was the highest reported suicide mortality rate in the world.

Figure 1: Suicide mortality rate in EU member states in 2015



Source: author's own elaboration; based on WHO

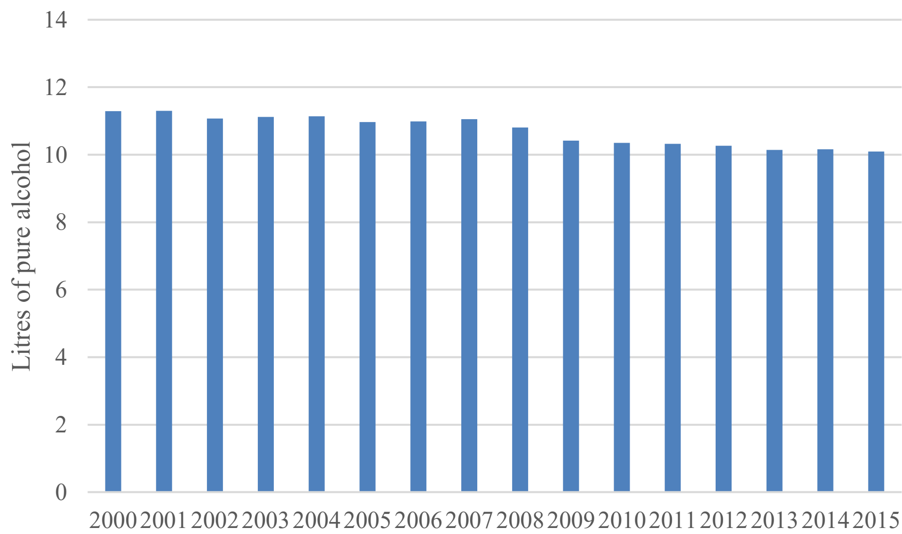
1.1.2 Harmful Use of Alcohol

Target 3.5 of the 2030 Agenda calls to 'Strengthen the prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol' (United Nations, 2015b). Progress on the target shall be indicated by (1) coverage of treatment interventions for substance use disorders, and (2) harmful use of alcohol, defined according to the national context as alcohol per capita consumption (aged 15 years and older) within a calendar year in litres of pure alcohol (United Nations, 2017).

In the Global Strategy to Reduce the Harmful Use of Alcohol, WHO (2010) defines harmful use of alcohol as 'the drinking that causes detrimental health and social consequences for the drinker, the people around the drinker and society at large, as well as patterns of drinking that are associated with increased risk of adverse health outcomes'. Babor et al. (2010) identify three key channels through which alcohol consumption may cause harm: firstly, physical toxicity of the substance negatively affecting consumer's body organs and tissues, potentially contributing to chronic health problems including but not limited to liver and heart disease or cancer; secondly, acute intoxication in the hours following consumption resulting in accidents, injuries, violence, and the like; thirdly, development of alcohol dependence. In light of this specification, reduction in harmful use of alcohol is perceived as vital in relation to achievement of a number of other SDG targets on good health and well-being, such as those concerning maternal and child health, reproductive health, non-communicable diseases, mental health, and deaths and injuries caused by road traffic accidents. Moreover, WHO (2018) contends that lowering harmful alcohol use aids in attaining Goal 10 of reduced inequality among and within countries.

In the European Health Report 2018, WHO Regional Office for Europe (2018) recognizes poor performance in lifestyle-related health quality determinants as a serious challenge for the region. In fact, Europe is tackling the highest rates of alcohol consumption and tobacco use in the world. Figure 2 shows the development of alcohol per capita consumption in 28 member states of the EU between years 2000 and 2015.

Figure 2: Recorded alcohol per capita consumption in the EU

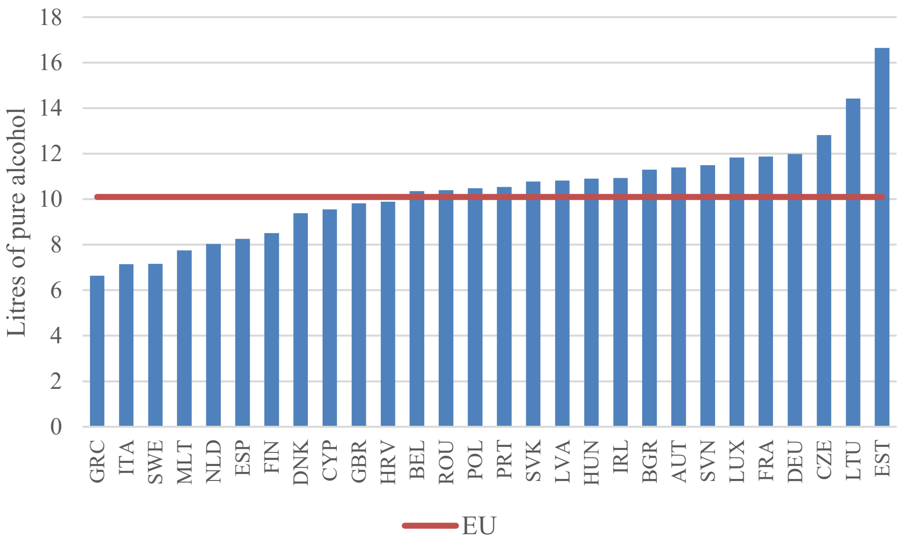


Source: author's own elaboration;

based on European Core Health Indicators Database and Eurostat

The EU-wide consumption rate remained relatively stable over the period, with a slightly decreasing trend from 2008 onwards. Among members of the EU, alcohol consumption rates showed largely contradicting patterns. In some countries, a steady decline occurred, as is the case of France, Luxembourg or the Netherlands. On the other hand, numerous member states firstly saw their alcohol per capita consumption rise at the beginning of the century, before experiencing a downward trend (e.g. Belgium, Finland, Greece, the United Kingdom). In other cases, no clear decreasing tendency was apparent (e.g. in the Czech Republic, Poland, Sweden). The 2015 alcohol per capita consumption in each member state is displayed in Figure 3, ranked from lowest to highest. There are considerable differences among countries at each side of the spectrum. In Estonia, the recorded value exceeded EU average by more than 60%, reaching 10 litres higher than in Greece.

Figure 3: Recorded alcohol per capita consumption in EU member states in 2015



Source: author’s own elaboration;

based on European Core Health Indicators Database and Eurostat

2. Literature Review

2.1 Economic Theory of Suicide

Fully recognizing that although suicide cannot be explained solely by economic conditions, Hamermesh and Soss (1974) introduce an economic theory of suicide, stating that an individual chooses to kill themselves in case their remaining discounted lifetime utility drops below a certain threshold. In a society of materialistic nature, it is expected that suicide rates will fall with higher permanent income, as higher income increases lifetime utility. Empirical support is found in cross-sectional data from 21 countries and time series data from the United States (US). According to Durkheim (c1951), suicide rates grow in times of economic contractions and booms. Economic contraction may reduce a person's utility as circumstances suddenly force them to restrict their requirements without time necessary for adjustment. Rapid rise in prosperity, on the other hand, stimulates intensified desires, often resulting in discontent as the next ambition repeatedly shadows previous achievements, leaving a person in a constant race towards elusive goals, without ability to reach satisfaction. However, in a times series analysis of US data from the period of 1940 – 1984, Yang (1992) does not find significant responsiveness of suicide rate to economic growth. Its impact varies among social groups. When faced with unemployment, an individual's economic prospects are lowered, increasing the probability that they commit suicide. Moreover, unemployment may lead to loss of self-confidence and evoke anxiety or depression, therefore becoming direct cause of suicide (Andrés, 2005). Hamermesh and Soss (1974) demonstrate a strong relation of suicide rate to unemployment, with rising sensitivity for older age groups.

Durkheim (c1951) further proposes that suicide rates are determined by the degree of social integration and regulation. Following this reasoning, fertility rate and divorce rate serve as indicators of social integration. Higher fertility fosters family relations, thus amplifying social ties and reducing the likelihood of suicide. Divorce, on the other hand, has opposite consequences. In a panel data study of 79 countries, Neumayer (2003) confirms both hypothesized effects. Although not introduced by Durkheim, female labour participation rate is also frequently considered among social integration factors. According to Stack (1998), when women join the labour force, they benefit from role accumulation. Among other advantages, women develop bonds with co-workers, reducing their social isolation, hence decreasing inclination towards suicide. On the contrary, higher female labour participation rate may result in role conflicts between men and women due to rising competition in the workforce, thus lowering social integration. The effect of female labour participation rate on suicide rate is deemed ambiguous, as it depends on which of the possible impacts prevails. Yang (1992) concludes suicide rates decrease as a larger share of women enters labour force. However, in a panel data study of 15 European countries, Andrés (2005) finds no significant effect on suicide rate.

Additionally, Durkheim (c1951) discusses relation among alcohol consumption pattern and suicide. His approach presumes alcoholism may only raise suicidal tendency indirectly as a result of causing mental disturbance. Therefore, on population level, correlation among the two measures is regarded merely coincidental. Nonetheless, later studies of Neumayer (2003) and Andrés (2005), which assess increase in alcohol per capita consumption as possible indication of social disintegration, produce evidence of its detrimental impact on suicide rate.

In summary, based on the preceding argumentation, a socio-economic model of suicide for country *i* in year *t* can be specified as

$$\begin{aligned} suicide\ rate_{it} = \alpha_i + \gamma_t + \beta_1 GDP\ per\ capita_{it} + \beta_2 economic\ growth_{it} \\ + \beta_3 unemployment\ rate_{it} + \beta_4 fertility\ rate_{it} \\ + \beta_5 divorce\ rate_{it} + \beta_6 female\ labour\ participation\ rate_{it} \\ + \beta_7 alcohol\ per\ capita\ consumption_{it} + \varepsilon_{it} \end{aligned}$$

β coefficients are slope parameters to be estimated. α represents country fixed effects; time-invariant factors which influence suicide rate but are not captured by explanatory variables in the model. Geographic location, prevailing lifestyle, and social perception of suicide belong to potential country fixed effects (Andrés, 2005). Masaryk (1904) also presents strong argumentation attributing prevalence of suicide in modern society to falling religiousness. Personal religious beliefs, as well as participation in religious communities serve as protective elements against suicide. Thus, countries with a lower share of religious population are deemed more susceptible to high suicide mortality rates. Time fixed effects, factors common to all countries but varying over time, are represented by γ. ε is a disturbance term varying with country and time.

2.2 Alcohol Consumption

In 1956, French demographer Sully Ledermann introduced what has become known as Ledermann's theory of alcohol consumption distribution. Ledermann's hypothesis was based on the assumption that an individual's drinking habits are subject to social mechanisms, rather than developing independently of their environment. Cultural norms and perception of alcohol consumption largely determine a person's alcohol consumption patterns, which form and adjust in a contagion-like manner within their social network. Following this reasoning, it was proposed that the number of heavy drinkers of alcohol in society increases with higher per capita alcohol consumption level. This was a novel perception, as previously, heavy drinkers were considered a group with alcohol drinking habits predominantly unaffected by those of remaining society (Skog, 2006).

According to Skog (2006), although Ledermann's work itself does not produce empirical support for his hypothesis regarding consumption distribution deemed robust enough due to poor data quality, it inspired numerous later data analyses testing whether harmful use of alcohol is linked to general consumption level. Skog (1985) concludes that if certain structural requirements are met, populations are inclined to behave collectively. Thus, the prevalence of heavy drinkers is expected to rise conjointly with alcohol consumption level in the population. Harmful use of alcohol is, however, not limited to concerns of heavy drinking. Edwards (1997) points out that higher population alcohol consumption level is associated with more alcohol-related problems in the population, affecting not only alcohol consumers themselves but also other individuals.

Such affirmative findings are the basis for the strategy of reducing harmful effects of alcohol use through policies designed to lower per capita consumption level. In a review of seven policy areas, Babor et al. (2010) establish that taxation resulting in higher alcohol prices constitutes a highly effective measure, alongside curtailed physical availability of alcohol beverages.

In a study of alcohol consumption in the European Union, Rabinovich et al. (2009) report alcohol affordability significantly impacts consumption levels and thus alcohol-related harm. Alcohol affordability, the ratio of income to alcohol price, rises either due to increased income or lower alcohol price. It is concluded that alcoholic beverages had become more affordable in most EU member states since mid-1990's due to decreasing real price, as a result of declining real value of employed excise duties. Babor et al. (2010) suggest that despite the well-recognized effectiveness of alcohol taxation policies, tax levels have not been increased proportionately to inflation and income growth. On the other hand, based on panel data analysis of 17 member states of the Organisation for Economic Co-operation and Development (OECD) in the period from 1975 to 2000 and of 22 EU countries in the period from 2000 to 2008, Nelson (2014) attributes rising alcohol affordability primarily to growing real incomes. With clear evidence of its high significance in relation to alcohol-related harm, it is appealed upon policy makers to reduce alcohol affordability through increasing excise duty on alcohol beverages and minimum price per unit (British Medical Association, 2012; Xuan et al., 2013).

Following the approach of Nelson (2014), a simple model of alcohol consumption for country *i* in year *t* can be specified as

$$ln(alcohol\ per\ capita\ consumption_{it}) = \alpha_i + \gamma_t +$$
$$+ \beta_1 ln(real\ per\ capita\ income_{it}) + \beta_2\ ln(real\ alcohol\ price\ index_{it}) + \varepsilon_{it}$$

where α represents a country fixed effect and γ a time fixed effect. β_1 and β_2 are model coefficients which can be interpreted as income and price elasticity of demand, respectively. ε is a stochastic error term.

3. Panel Data Theory

Panel data sets, also referred to as longitudinal data sets, contain information on a fixed set of cross-sectional units (e.g. individuals, firms, countries) across time. The same cross-sectional units are followed in each period. Panel data analysis allows to control for unobserved time-invariant characteristics inherent to each unit that may be correlated with independent variables in the econometric model (Greene, 2012). This presents an important advantage in dealing with the issue of omitted variable bias, facilitating the use of a simple model.

A panel data set which holds information about every cross-sectional unit in each of T time periods is called balanced. The number of observations in such data set equals NT, where N is the number of cross-sectional units. In case observations for some time periods are missing, resulting in a total number of observations strictly smaller than NT, the data set is referred to as unbalanced. Analysis of an unbalanced data set may entail application of advanced econometric methods (Wooldridge, 2016).

In the study of development in indicators of the 2030 Agenda for Sustainable Development in countries of the European Union, employing panel data methods is justifiable as the explored data set has both cross-sectional and time-series dimension, monitoring member states (cross-sectional units) over a period of years.

Greene (2012) proposes a general regression function for panel data analysis in the form

$$y_{it} = x'_{it}\beta + z'_{i}\alpha + \varepsilon_{it} = x'_{it}\beta + c_i + \varepsilon_{it}$$

where i denotes a cross-sectional unit and t denotes a time period. x'_{it} consists of K explanatory variables, excluding a constant. $z'_{i}\alpha$ represents heterogeneity across the cross-sectional units, also called individual effect. z_i is composed of a constant term and a set of features characteristic of a single unit (or a group of units) that affect the dependent variable y_{it} and do not vary over time. These features may or may not be observed. The idiosyncratic error ε_{it} contains unobserved effects influencing y_{it} which change in time. Together with the individual effect, it is referred to as composite error v_{it}; $v_{it} = c_i + \varepsilon_{it}$. The analysis aims at consistent and efficient estimation of partial effects, captured by the β coefficients.

3.1 Estimation Methods

Based on the theoretical approach of Greene (2012) and Wooldridge (2016), the following elementary estimation methods were considered in panel data analysis:

1. Pooled Regression: When z_i consists of a constant term only, in other words, there are no time-fixed differences among cross-sectional units that would not be captured by the explanatory variables included in the model, it is viable to estimate equation parameters using pooled ordinary least squares (OLS). If the classical linear model assumptions are met, the estimation produces consistent and efficient parameter estimates.

2. First Differencing (FD): Frequently, there are unobserved individual effects present which are correlated with explanatory variables in the model. In such case, pooled regression becomes unfeasible due to arising omitted variables bias, which causes OLS estimator to be biased and inconsistent. The method of first differencing handles said correlation by subtracting regression equations in adjacent time periods prior to estimation. As a result of first differencing, heterogeneity is eliminated from the model:

$$\Delta y_{it} = (\Delta x_{it})'\beta + \Delta\varepsilon_{it}; \qquad i = 1, \ldots, N, t = 2, \ldots, T$$

where $\Delta y_{it} = y_{it} - y_{i,t-1}$ and analogously for Δx_{it} and $\Delta\varepsilon_{it}$.

Along with heterogeneity, all other time-invariant variables are transformed from the model, which may be undesirable if the interpretation of their effect is of interest. The number of observations decreases by one period; after first differencing, a balanced panel consists of $N(T-1)$ observations.

3. Fixed Effects (FE): Similarly to first differencing, the fixed effects method is based on the assumption that individual effects are correlated with explanatory variables. Fixed effects transformation eliminates individual effects as well as any other variables constant over time from the model by way of time demeaning:

$$\ddot{y}_{it} = (\ddot{x}_{it})'\beta + \ddot{\varepsilon}_{it}; \quad i = 1, \ldots N, t = 1, \ldots, T$$

where $\ddot{y}_{it} = y_{it} - \bar{y}_i = y_{it} - \frac{1}{T}\sum_{t=1}^{T} y_{it}$ and analogously for $\ddot{x}_{it}$ and $\ddot{\varepsilon}_{it}$.

The transformed equation can be estimated with pooled OLS. If $T = 2$, first differencing and fixed effects estimation produce the same results. For $T > 2$, when ε_{it} are serially uncorrelated, fixed effects is more efficient. In case ε_{it} follow a random walk, first differencing is preferred.

4. Random Effects (RE): Opposite to first differencing and fixed effects, in a random effects model unobserved individual effects are assumed uncorrelated with all explanatory variables across time. By construction, the composite errors ν_{it} then suffer from serial correlation. In such case, pooled regression provides inefficient estimates (albeit consistent). Hence the more efficient feasible generalized least squares estimation procedure is adopted.

Several tests were performed in order to determine which model specification is best suitable. Empirical analysis was carried out in R software, with the use of *plm* package as outlined by Croissant and Millo (2008), which also facilitates the selected testing procedures. Based on the result of pooled OLS estimation, Lagrange multiplier test for two-ways effect reveals presence of individual and time fixed effects. Lagrange multiplier test can be further applied to select among pooled OLS and random effects model, whilst an F test determines whether pooled OLS or fixed effects model is more appropriate. Hausman test enables choice between fixed and random effects estimation. Under the null hypothesis, both models are consistent; random effects is, however, asymptotically more efficient. Under the alternative hypothesis, random effects is inconsistent, thus resulting in clear preference of fixed effects. Moreover, Breusch-Godfrey test for serial correlation among idiosyncratic errors was carried out, along with Breusch-Pagan test for the presence of heteroskedasticity, which is a part of *lmtest* package. In case of their detection, *sandwich* package allows for estimation with robust standard errors, a necessary correction to prevent invalid inference. All hypothesis testing was conducted at the 5% significance level.

4. Data Specification

Annual data on suicide mortality and alcohol consumption in 28 European Union member states were obtained from the WHO Mortality Database and European Core Health Indicators Database, respectively. The primary source of data on explanatory variables in both models was the World Bank's World Development Indicators Database, with the exception of divorce rate (retrieved from Eurostat) and real alcohol price index (retrieved from FRED, Federal Reserve Bank of St. Louis). In case of real alcohol price index, monthly data was averaged in order to establish annual figures.

With respect to data availability, for the model of suicide mortality rate, a dataset for period from 1996 to 2014 was created. Due to a lack of historical observations in their time series on suicide rate and divorce rate, respectively, two member states were excluded from the panel; namely Cyprus and Malta. Table 2 specifies the data relevant to each variable, along with any missing observations. Suicide rate reported in WHO Mortality Database is age-standardized, which facilitates country-level comparisons.

Similarly, for the model of alcohol consumption, a dataset covering period from 2000 to 2015 in 27 EU member states was assembled. The dataset does not include Croatia for the reason of insufficient data availability on real alcohol price index. Table 3 summarizes data regarding the dependent and two independent variables in the model.

With a small number of missing observations, the two panel data sets were originally unbalanced. For the purpose of conducting empirical analysis on balanced panels, the missing data was imputed. Gelman and Hill (2007) specify available methods for missing data treatment. When selecting a suitable method, the reason behind data unavailability needs to be considered. Four general cases are classified, from least to most serious: (1) missing completely at random, (2) missing at random, (3) missing in dependence on unobserved predictors of the value, (4) missing in dependence on the value itself. As no underlying pattern among the missing observations was apparent, it was assumed they are missing at random, and the data was imputed by method of carrying forward the last observed value (or in case such option was not possible, by inputting the subsequent observed value). Divorce rate in Ireland in 1996 was set to 0, as prior to 1997, divorce was prohibited (OECD Family Database, 2018).

Furthermore, a careful data inspection revealed two outliers in the case of suicide rate in Slovakia in years 2006 and 2007. The two respective values equal 0, a sudden sharp drop between preceding and succeeding ones in the time series. With consideration

Table 2: Data overview, model of suicide mortality rate

Variable name	Data specification	Missing observations
Suicide rate	Age-standardized death rate due to intentional self-harm, per 100 000 inhabitants	Poland: 1997 – 1998 Portugal: 2004 – 2006 Slovakia: 2011
GDP per capita	Gross domestic product per capita, in constant 2010 US dollars	None
Economic growth	Gross domestic product per capita annual percentage growth rate (based on annual figures in constant 2010 US dollars)	None
Unemployment rate	Unemployment, in percent of total labour force	None
Fertility rate	Fertility rate, number of births per woman	None
Divorce rate	Crude divorce rate, per 1 000 inhabitants	Ireland: 1996
Female labour participation rate	Female labour participation rate, in percent of female population aged 15 years and older	None
Alcohol per capita consumption	Recorded amount of alcohol consumed per adult (aged 15 years and older) over a calendar year, in litres of pure alcohol	Hungary: 2004

of suicide mortality rates in 2006 and 2007 reported in DATAcube of the Statistical Office of the Slovak Republic, which do not deviate from other years significantly, the 0 values obtained from the WHO Mortality Database seem highly unrepresentative. Moreover, the OECD Database, which sources suicide rate data from the WHO Mortality Database, indicates no availability of the two observations concerned. The zero values may be a result of a reporting error. It was therefore concluded that a suitable approach was treating the outliers as missing data and applying the method of last value carried forward to obtain a balanced panel.

Table 3: Data overview, model of alcohol consumption

Variable name	Data specification	Missing observations
Alcohol per capita consumption	Recorded amount of alcohol consumed per adult (aged 15 years and older) over a calendar year, in litres of pure alcohol	Hungary: 2004
Real per capita income	Gross domestic product based on purchasing power parity, in constant 2011 international dollars	None
Real alcohol price index	Harmonized index of consumer prices for alcoholic beverages (index year 2011)	Hungary: 2000 Romania: 2000

5. Empirical Model

5.1 Modelling for Suicide Mortality Rate

Based on models introduced by Andrés (2005) and Neumayer (2003), a model for suicide mortality rate, indicator 3.4.2 of Sustainability Development Goals, was specified as

$$\begin{gathered} ln(suicide\ rate_{it}) = \alpha_i + \gamma_t + \beta_1 GDP\ per\ capita_{it} + \beta_2 economic\ growth_{it} + \\ + \beta_3 unemployment\ rate_{it} + \beta_4 fertility\ rate_{it} + \\ + \beta_5 divorce\ rate_{it} + \beta_6 female\ labour\ participation\ rate_{it} + \\ + \beta_7 alcohol\ per\ capita\ consumption_{it} + \varepsilon_{it} \end{gathered}$$

Following the approach of Andrés (2005), suicide rate was transformed with natural logarithm in order to correct for its skewed distribution. Further, GDP per capita was entered in thousands of constant 2010 US dollars.

On the basis of theory developed by Durkheim (c1951) and Hamermesh and Soss (1974), the hypotheses about effects of the selected socioeconomic variables on suicide rate were:

- Higher income increases lifetime utility, thus higher GDP per capita decreases suicide rate.
- Economic growth increases expected lifetime utility, hence reducing suicide rate.
- Unemployment lowers future economic prospects of an individual. A rise in unemployment leads to more suicides committed.
- Higher fertility rate and higher female labour participation rate foster social integration, which results in decreased suicide rate.
- Growing divorce rate and alcohol consumption signify social disintegration, causing an increase in suicide rate.

The results of estimation with four panel data methods summarized in Chapter 3 are presented in Table 4. The Breusch-Pagan test revealed presence of heteroskedasticity. Moreover, serial correlation among error terms was detected, necessitating the use of robust standard errors. Testing also confirmed the need to control for country and time fixed effects. The F test and Lagrange Multiplier test favour fixed effects and random effects over pooled OLS, respectively. Among the two, Hausman test revealed random effects as inconsistent, making fixed effects a preferable choice. Therefore, fixed effects and first differencing are considered for final specification.

Table 4: Regression results - Suicide mortality rate

	Dependent variable: ln(suicide rate)			
	Pooled OLS	FD	FE	RE
GDP per capita	-0.007*	0.016**	-0.008	-0.007**
	(0.004)	(0.008)	(0.006)	(0.003)
Economic growth	0.036***	-0.002	-0.002	-0.002
	(0.011)	(0.002)	(0.002)	(0.002)
Unemployment rate	0.010	0.008***	0.009*	0.009*
	(0.016)	(0.002)	(0.005)	(0.005)
Fertility rate	0.432	-0.130	-0.173	-0.140
	(0.348)	(0.096)	(0.207)	(0.200)
Divorce rate	0.288**	0.071*	0.084	0.098
	(0.118)	(0.042)	(0.059)	(0.061)
Female labour participation rate	0.004	0.002	-0.003	-0.002
	(0.015)	(0.004)	(0.006)	(0.006)
Alcohol per capita consumption	0.039	0.001	-0.019*	-0.018*
	(0.025)	(0.006)	(0.011)	(0.010)
Constant	0.724	-0.019		2.973***
	(0.835)	(0.015)		(0.407)
Observations	494	468	494	494
R^2	0.383	0.100	0.530	0.506
Adjusted R^2	0.350	0.052	0.477	0.480

Note: *p<0.1; **p<0.05; ***p<0.01
Robust standard errors reported in parentheses.
For full table including time dummy variables, see Appendix 2.

The signs of estimated slope parameters align with hypothesized effects in case of economic growth, unemployment rate, fertility rate and divorce rate. Under both FD and FE, the estimated sizes of effect on suicide rate are fairly similar in magnitude. However, coefficient estimates on GDP per capita, female labour participation rate and alcohol per capita consumption have contradicting signs in the two specifications.

Under FD, GDP per capita and unemployment rate are statistically significant under the 5% significance level, along with divorce rate under the 10% significance level. In FE model, no explanatory variables showed statistical significance under the usual 5% significance level. Unemployment rate and alcohol per capita consumption are the only explanatory variables statistically significant under the 10% significance level.

As indicated by the occurring discrepancies among results of first differencing and fixed effects estimation, drawing inference from these results shall be conducted with substantial caution. Firstly, the violation of homoskedasticity assumption hinders efficiency comparison of the FD and FE estimator. Moreover, the models may have produced biased estimates in case the key assumption of strict exogeneity were violated. Generally, whilst the bias of FE estimator tends to zero as T increases, that of FD does not depend on the length of time period of the data panel (Wooldridge, 2016).

Overall, in both models, economic growth, fertility rate and female labour participation rate are not found to significantly affect suicide rate. Sensitivity to unemployment rate has been confirmed by both specifications. A rise in unemployment rate by one percentage point is estimated to correspond to an increase in suicide mortality rate approximately by 0.8% under FD, by 0.9% under FE. FD model further suggests that a rise in GDP per capita by 1 000 constant 2010 US dollars is associated with a rise in suicide rate by 1.6%; opposite to hypothesized effect. Growth in divorce rate by one divorce per 1 000 inhabitants is estimated to induce increase in suicide rate by 7.4%. Results of FE estimation indicate that alcohol per capita consumption higher by 1 litre of pure alcohol deters suicide rate by 1.9%. Altogether, as previously emphasized, establishing causal relations in socio-economic models of suicide shall be exercised with ample prudence, as such models inherently do not capture the individual concerns underlying suicide behaviour.

In view of Masaryk's (1904) approach towards effects of religiousness on suicide, share of religious population was considered as a possible country fixed effect entering the model of suicide mortality rate. Masaryk (1904) attributes the protective power of religious beliefs specifically to monotheistic faith. Special Eurobarometer 341 (European Commission, 2010) reports survey results of religious beliefs in member states of the EU. Comparison of the share of population who claim they believe there is a God and the corresponding obtained country fixed effect yields a correlation coefficient of -0.47. The size of the correlation coefficient does not signify a particularly strong linear relationship among the two variables, implying that there are likely other key factors besides religiousness composing the country fixed effect on suicide rates in EU member states.

5.2 Modelling for Harmful Use of Alcohol

In modelling for indicator 3.5.2 of Sustainable Development Goals, based on the literature review in Chapter 2, the following regression equation was regarded:

$$ln(alcohol\ per\ capita\ consumption_{it}) = \alpha_i + \gamma_t +$$
$$+ \beta_1 ln(real\ per\ capita\ income_{it}) + \beta_2\ ln(real\ alcohol\ price\ index_{it}) + \varepsilon_{it}$$

The parameters of interest are β_1 and β_2. Due to the log-log specification form, they represent income and price elasticity of alcohol consumption, respectively. With regard to previous studies, it was hypothesized that higher real per capita income makes alcoholic beverages relatively more affordable, hence leads to their increased consumption. On the contrary, higher real alcohol price decreases alcohol affordability, and was thus hypothesized to result in reduced alcohol consumption.

The model equation was estimated by four estimation methods as described in Chapter 3. Testing revealed that country and time fixed effects are indeed present in the model, thus making pooled OLS unsuitable as it assumes no unobserved individual fixed effects. Fixed effects and random effects estimation were proved as more appropriate methods. The Hausman test showed enough evidence to reject the null hypothesis, therefore giving preference to FE over RE estimation, which is inconsistent under the alternative hypothesis. Furthermore, the model was tested for heteroskedasticity and serial correlation among error terms. Whilst the null hypothesis of homoskedasticity in the Breusch-Pagan test could not be rejected, the Breusch-Godfrey test confirmed presence of serial correlation. Therefore, estimation with standard errors robust to autocorrelation was adopted. Results of the four respective estimation methods are summarized in Table 5.

In fixed effects estimation, real per capita income is statistically significant under the 5% significance level, whilst real alcohol price index is not. This is a prominent disparity in comparison to the regression results of first differencing, under which both explanatory variables display high statistical significance. In terms of efficiency, FE cannot be clearly favoured over FD due to the autocorrelation among error terms.

Table 5: Regression results – Alcohol per capita consumption

	Dependent variable: ln(alcohol per capita consumption)			
	Pooled OLS	FD	FE	RE
ln(real per capita income)	0.021	0.650***	0.802***	0.641***
	(0.064)	(0.124)	(0.105)	(0.093)
ln(real alcohol price index)	-0.022	-0.335***	-0.142	-0.097
	(0.255)	(0.065)	(0.126)	(0.120)
Constant	2.228**	-0.005		-3.737***
	(1.009)	(0.010)		(1.146)
Observations	432	405	432	432
R^2	0.020	0.211	0.496	0.399
Adjusted R^2	-0.020	0.178	0.440	0.375

Note: *p<0.1; **p<0.05; ***p<0.01
Robust standard errors reported in parentheses.
For full table including time dummy variables, see Appendix 4.

In both models, the estimated signs of slope parameters are as hypothesized. First differencing yields income and price elasticity similar to those obtained by Nelson (2014). Interpreted causally, a rise in real per capita income by 1% is expected to increase alcohol per capita consumption by approximately 0.65%, ceteris paribus. Growth in real alcohol price by 1% is expected to deter alcohol consumption by approximately 0.34%, ceteris paribus. Under FE, the ceteris paribus effect of an increase in real per capita income by 1% is an estimated rise in alcohol per capita consumption by approximately 0.8%; whilst a change in real alcohol price does not have a statistically significant effect. However, as is the case when modelling for suicide mortality rate, caution shall be taken when inferring causality. The models of harmful use of alcohol may also suffer from violation of underlying assumptions. In particular, potential presence of endogeneity may lead to biased results. In regard to the regression results of both first differencing and fixed effects, it may be concluded that alcohol consumption is relatively more elastic with respect to changes in income than to changes in alcohol price.

6. Forecast Model

6.1 ARIMA Forecast

In the pursuit of forecasting future advancement in attaining healthy lives and well-being in countries of the European Union within the framework of the 2030 Agenda for Sustainable Development, time series models of Autoregressive Integrated Moving Average for the two SDG indicators concerned were utilized. An ARIMA forecast is a simple quantitative forecast method, which aids assessment of future development by extrapolating values based on past patterns present in the respective time series data. The method does not engage factors underlying the development in the variable of interest; forecasting for all explanatory variables employed in panel data models analysed in Chapter 5 is beyond the scope of this thesis.

An ARIMA forecast for suicide mortality rate and alcohol per capita consumption was carried out for 27 and 28 member states of the EU, respectively. Time series data were obtained from the same sources as described in Chapter 4. For both indicators, annual data from 1990 until the most recent year available was utilized. In case of suicide mortality rate, the time series ends in 2014 for 5 member states, in 2015 for 14 and in 2016 for 8 member states. Cyprus was excluded from the analysis due to a lack of observations prior to year 2004. The latest data on alcohol per capita consumption are from 2015 (6 member states) or 2016 (remaining 22 countries). Four of the 55 time series start between one to four years later than 1990.

In order to forecast future development for the EU as a whole, EU-wide values for the two indicators were calculated as a population-weighted average of country-level data. Annual population data were obtained from Eurostat.

Based on inspection of recent trends in the time series on suicide mortality rate and alcohol per capita consumption, it was hypothesized that jointly the EU is indeed progressing in the right direction of meeting the two corresponding SDG health targets by 2030, although it may fall short of reducing suicide mortality rate by full one third. Regarding individual member states, sufficient decrease in suicide mortality rate was considered fairly unlikely in Greece, Ireland, Italy, the Netherlands, Portugal, Spain and the United Kingdom. Forecasted development in Bulgaria, Latvia, Malta and Sweden was expected to lack decreasing tendency in harmful use of alcohol.

The ARIMA forecasting was carried out in R software with the use of *forecast* package, as outlined by Hyndman and Khandakar (2008). Procedure of selecting the appropriate ARIMA model order followed the approach of Hyndman and Athanasopoulos (2018) and Teetor (2011). As most time series of suicide mortality rate and alcohol per capita consumption were upon first inspection non-stationary, the number of differencing necessary to eliminate non-stationarity was determined with a series of Kwiatkowski-Phillips-Schmidt-Shin tests for unit root. Subsequently, the suitable autoregressive and moving average order were established. R software facilitates an automatic ARIMA model selection, which largely aligned with the results of manual selection process and was thus employed for performing the desired forecasts. On rare occasions, a different hand-selected specification was considered, however, it could not compensate for the key drawback of the model caused by the largely limited length of the time series applied.

The obtained forecast values for 2030, the closing year of Sustainable Development Goals, are presented in Table 6. With respect to the relatively short time span of the time series used in ARIMA modelling, as well as due to the substantial length of the forecast period, it is important to stress that these results are merely indicative. As is customary in forecasting, the ARIMA forecast assumes external conditions will evolve in the same manner as they did previously. Naturally, this may not be the case in reality. Events such as economic crisis, natural disaster, crucial policy alteration and other may change the course of development significantly. To ensure a fair cross-country comparison, Table 6 displays 2014 suicide rates and 2015 alcohol per capita consumption since more recent observations have not yet been reported for all member states.

Table 6: Forecasted values of suicide mortality rate and alcohol per capita consumption in 2030

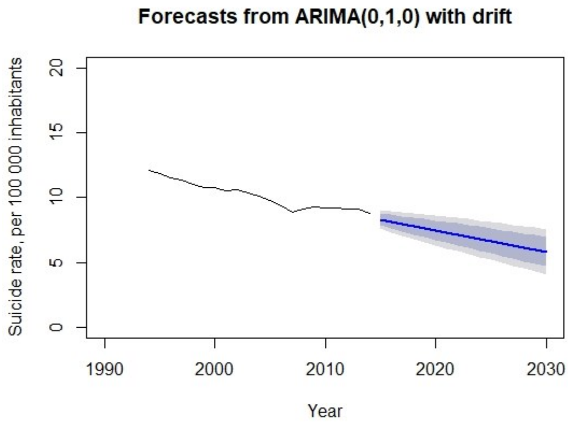
	Suicide mortality rate		Alcohol per capita consumption	
	2014	2030 forecast	2015	2030 forecast
European Union	8.8	5.8	10.1	8.9
Austria	11.2	4.4	11.4	11.7
Belgium	13.5	13.3	10.4	11.0
Bulgaria	6.9	6.9	11.3	11.5
Croatia	12.3	7.2	12.2	12.4
Cyprus	-	-	9.6	9.6
Czech Republic	11.2	6.4	12.8	12.2
Denmark	8.7	2.4	9.4	9.6
Estonia	15.2	12.4	16.6	15.4
Finland	12.8	1.9	8.5	9.5
France	10.7	6.1	11.9	9.6
Germany	8.8	5.2	12.0	8.8
Greece	4.0	3.0	6.6	4.5
Hungary	14.2	1.5	10.9	7.5
Ireland	10.1	10.9	10.9	11.5
Italy	5.0	4.6	7.1	5.0
Latvia	16.0	15.5	10.8	11.4
Lithuania	26.1	4.7	14.4	13.6
Luxembourg	9.8	8.5	11.8	9.2
Malta	6.6	5.8	7.8	7.9
Netherlands	8.9	8.4	8.0	6.8
Poland	13.0	13.3	10.5	10.4
Portugal	7.9	6.8	10.5	8.2
Romania	8.8	7.7	10.4	10.4
Slovakia	8.1	4.1	10.8	10.1
Slovenia	13.7	6.1	11.5	10.8
Spain	6.2	5.6	8.3	6.2
Sweden	9.9	7.2	7.2	7.1
United Kingdom	6.6	6.7	9.8	10.1

Source: author's own elaboration; based on WHO Mortality Database, European Core Health Indicators Database and Eurostat

6.2 Results and Discussion

Figure 4 and Figure 5 display forecasted development in suicide mortality rate and alcohol per capita consumption in the European Union until year 2030. Point forecasts are depicted by the blue line, whilst the dark grey and light grey area represent the 80% and 95% forecast confidence interval, respectively.

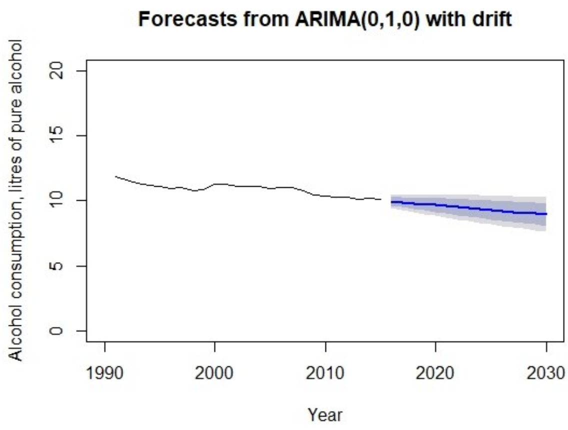
Figure 4: ARIMA forecast – Suicide mortality rate in the EU



Source: author's own elaboration; based on WHO Mortality Database and Eurostat

Note: Based on 27 EU member states; Cyprus was excluded due to lack of data. Age-standardized suicide rate reported.

Figure 5: ARIMA forecast – Alcohol per capita consumption in the EU



Source: author's own elaboration;
based on European Core Health Indicators Database and Eurostat

The ARIMA forecast indicates that collectively, EU member states shall be on track to achieve reduction in suicide mortality rate as specified by SDG Target 3.4.

The forecasted 5.8 deaths per 100 000 inhabitants in 2030 represent a decline by slightly more than one third compared to the 2014 value. The upper bound of the 95% confidence interval lies below the 2014 suicide mortality rate, indicating that a positive development toward target attainment can indeed be expected.

Forecasted harmful use of alcohol in the EU, measured by level of alcohol per capita consumption, shows a slightly decreasing trend, thus satisfying the key objective set out by Target 3.5 of the UN's 2030 Agenda for Sustainable Development. Forecasted EU-wide alcohol per capita consumption in year 2030 is approximately 11.5% lower compared to 2015. Since the SDG framework does not specify a desired extent of reduction in harmful use of alcohol, it is not possible to further judge whether such progress follows a satisfactory pace.

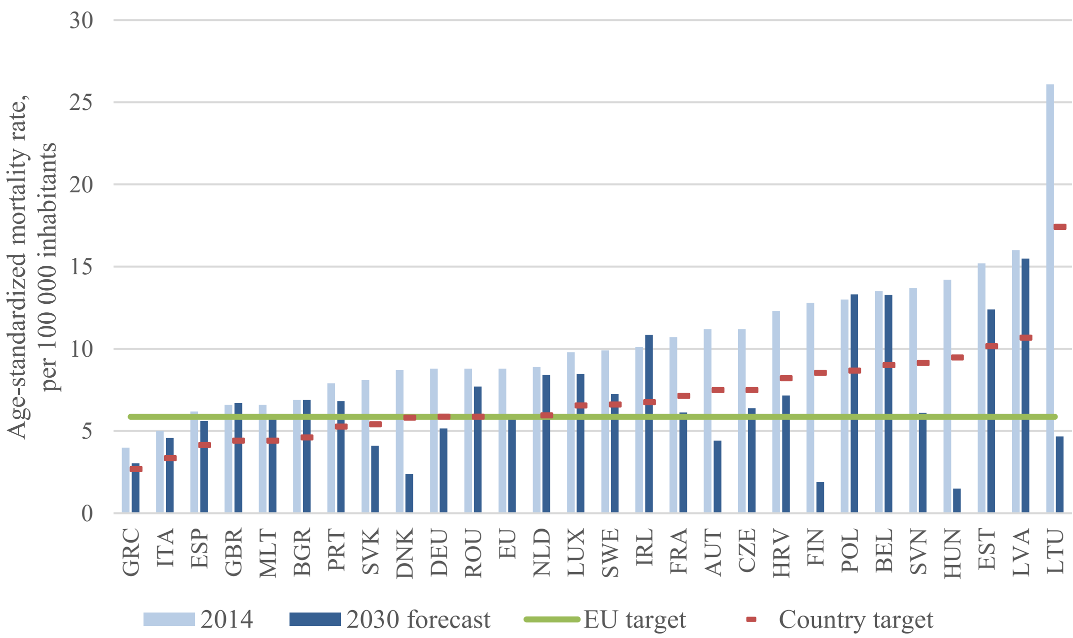
In order to systematically review the results of country-specific forecasting for the two SDG indicators, each country was assigned a probability of target fulfilment based on its 2030 point forecast and 95% confidence interval in the following manner:

- Very high probability of fulfilment in case the entire confidence interval lies below target value.
- High probability of fulfilment in case the forecast value lies below target value but upper bound of confidence interval exceeds the threshold.
- Fair probability of fulfilment in case the lower bound of confidence interval lies below target value but forecast value does not meet the threshold.
- Low probability of fulfilment in case the entire confidence interval lies above target value.

For suicide mortality rate, the target value was calculated as two thirds of recorded 2014 value in the relevant member state. Due to a lack of a quantifiable aim regarding reduction in harmful use of alcohol, the threshold for alcohol per capita consumption was set equal to its 2015 value in the relevant member state. Owing to the fact that countries of the EU have entered the 2030 Agenda with largely varying starting levels of suicide mortality rate and alcohol per capita consumption, evaluation of forecasts only considering these country-specific targets significantly hinders comparison among member states. A country may perform poorly in terms of country-specific targets; however, simultaneously, its forecasted suicide mortality rate or alcohol per capita consumption may be rather favourable compared to other EU countries. Therefore, for each indicator, an EU-wide target was established in the same way as individual country targets. That is, the threshold value for suicide mortality rate was set to two thirds of population-weighted EU average suicide mortality rate in 2014, and the threshold value for harmful use of alcohol equal to the 2015 population-weighted EU average alcohol per capita consumption. Assessment of meeting country-specific and EU-wide targets is summarized in Table 7.

Eleven of the 27 examined member states of the EU are highly or very highly likely to achieve a reduction in their suicide mortality rate by one third between 2014 and 2030. The same number of states is expected to meet the EU-wide target. In four states, probability of bringing suicide mortality rate below the desired country-specific level is low. Three of them are also unlikely to experience a decrease in suicide mortality rate below two thirds of the 2014 EU level; specifically, Ireland, the Netherlands, and Poland. Comparison of 2030 point forecast with 2014 suicide mortality rate, along with country-specific and EU-wide target values is presented in Figure 6. For forecasted development until year 2030 including forecast confidence intervals, see Appendix 5. In all member states, ARIMA forecast of suicide mortality rate shows either a decreasing trend or stays level over the course of the forecast period.

Figure 6: ARIMA forecast – Suicide mortality rate by EU member state



Source: author’s own elaboration; based on WHO Mortality Database and Eurostat

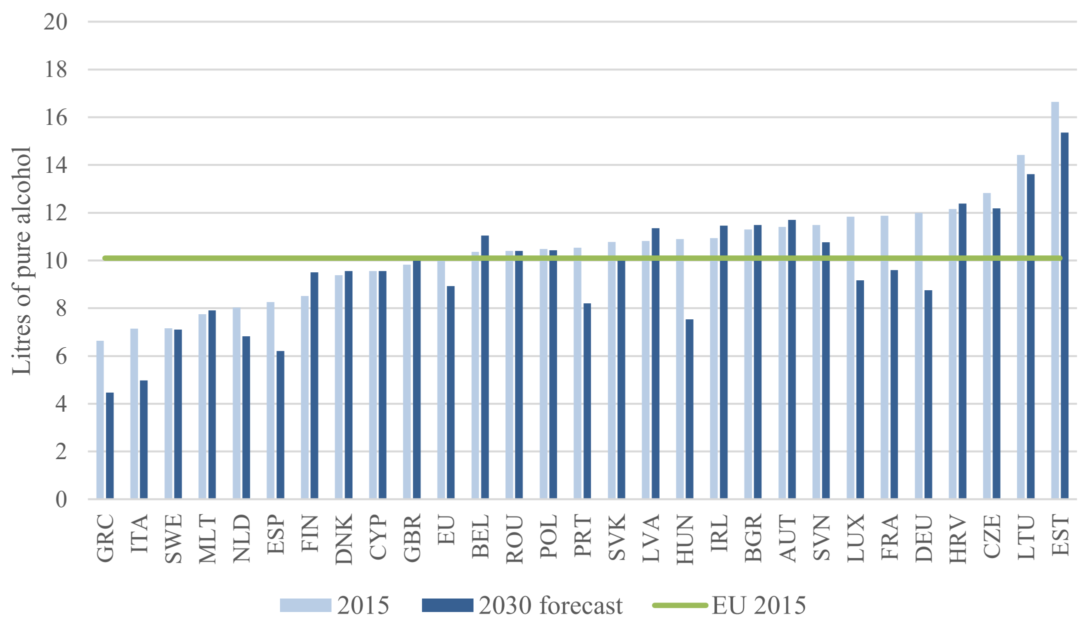
Table 7: Probability of target fulfilment

	Suicide mortality rate		Alcohol per capita consumption	
	Country target	EU target	Country target	EU target
Austria	high	high	fair	fair
Belgium	fair	fair	fair	fair
Bulgaria	fair	fair	fair	fair
Croatia	high	fair	fair	fair
Cyprus	-	-	fair	high
Czech Republic	high	fair	high	low
Denmark	high	high	fair	high
Estonia	fair	fair	high	fair
Finland	very high	high	fair	high
France	high	fair	very high	high
Germany	high	high	very high	high
Greece	fair	very high	high	very high
Hungary	very high	high	high	high
Ireland	low	low	fair	fair
Italy	fair	high	high	very high
Latvia	fair	fair	fair	fair
Lithuania	high	high	high	fair
Luxembourg	fair	fair	very high	high
Malta	fair	high	fair	high
Netherlands	low	low	high	very high
Poland	low	low	high	fair
Portugal	fair	fair	high	high
Romania	fair	fair	fair	fair
Slovakia	high	high	high	fair
Slovenia	high	fair	high	fair
Spain	fair	high	high	very high
Sweden	fair	fair	high	very high
United Kingdom	low	fair	fair	fair

Source: author’s own elaboration; based on WHO Mortality Database, European Core Health Indicators Database and Eurostat

As indicated in Table 7, there is very high probability that 3 EU member states will succeed in reducing alcohol per capita consumption in the duration of the SDG programme. High probability has been assigned to further 13 countries. In consideration of country-level target, low probability of fulfilment is not a concern for any member state. Regarding the EU-wide target, only 14 member states are highly or very highly likely to achieve a decrease in their alcohol per capita consumption below the 2015 EU level. Of those, nine already satisfied the target in 2015. According to the ARIMA forecast, the Czech Republic is the only member state rather unlikely to curtail harmful use of alcohol enough to meet the 2015 EU threshold. Figure 7 displays alcohol per capita consumption in 2015 along with the respective 2030 forecast for all 28 EU members. Generally, the health indicator forecast follows either a decreasing trend or remains largely unchanged over the course of the forecast period. In Finland and the United Kingdom, a very modest increasing tendency in alcohol per capita consumption was established. For country-specific forecasted progress up to year 2030 including confidence intervals, see Appendix 6.

Figure 7: ARIMA forecast – Alcohol per capita consumption by EU member state



Source: author's own elaboration;

based on European Health Core Indicators Database and Eurostat

The results of ARIMA forecasting mostly align with hypotheses stated in section 6.1. Forecasted development in both health quality indicators for the EU as a whole displays favourable progress towards the relevant SDG target attainment. In addition, unlike expected, the targeted reduction in suicide mortality is forecasted to be met by 2030. Member states which were regarded as unlikely to sufficiently decrease suicide mortality rate or harmful use of alcohol during hypotheses formulation all scored with fair or low probability of the corresponding target fulfilment in Table 7 overview.

Conclusion

In this thesis, two indicators of healthy lives and well-being embedded in the framework of the United Nations 2030 Agenda for Sustainable Development were analysed. Firstly, suicide mortality rate, an indicator of achieving reduction in premature mortality and promoting mental health. Secondly, harmful use of alcohol measured as alcohol per capita consumption, which reflects progress upon prevention and treatment of substance abuse. The empirical analysis focused solely on member states of the European Union. Its aim was to answer the question 'What are the socio-economic determinants of healthy lives in the EU?' and 'Is the EU on the right path to achieve healthy lives by 2030?'.

In relation to the first question, socio-economic determinants of the two respective health quality indicators were examined with the use of panel data methods. Model of suicide mortality rate followed the approach of Andrés (2005). Based upon theory introduced by Durkheim (c1951) and Hamermesh and Soss (1974), GDP per capita, economic growth and unemployment rate served as proxy of remaining lifetime utility. Fertility rate, divorce rate, female labour participation rate and alcohol per capita consumption represented level of social integration. Under first differencing specification, GDP per capita and unemployment rate were found statistically significant under the 5% significance level, along with divorce rate under the 10% significance level. The established effects of higher unemployment rate and higher divorce rate are as hypothesized; that is, resulting in increased suicide mortality rate. On the other hand, the expected deterrent effect of higher GDP per capita on suicide was not confirmed. In fixed effects estimation, unemployment rate and alcohol per capita consumption were the only variables statistically significant under the 10% significance level. The estimated effect of unemployment on suicide aligns with results of first differencing. However, the estimated slope parameter on alcohol per capita consumption has opposite sign than expected. Overall, both estimation methods suggest that on country level, suicide mortality rate is sensitive to unemployment rate, whilst economic growth, fertility rate and female labour participation rate do not seem to have a significant impact.

In model of alcohol per capita consumption, effects of alcohol affordability were studied, decomposed into income per capita and alcohol price index as employed by Nelson (2014). Regression results support hypothesized effects. Under both first differencing and fixed effects model specification, income per capita showed strong statistical significance under the 5% significance level. Alcohol price index displayed statistical significance under first differencing only. FD estimation produced income and price elasticity corresponding to Nelson's results. Altogether, alcohol consumption was concluded as relatively more sensitive to changing income than alcohol prices.

To answer the second research question, development in the two health quality indicators until the closing year of Sustainable Development Goals programme was forecasted. ARIMA forecast revealed that on the whole, European Union shall be on track to achieve the relevant targets; that is, by year 2030, decrease suicide mortality rate by one third and reduce harmful use of alcohol. Unfortunately, due to a lack of a quantifiable target regarding substance abuse, the SDG framework does not permit to assess whether the forecasted progress in lowering harmful use of alcohol follows a satisfactory pace.

In addition, results of country-level forecasts were reviewed. Out of 27 EU member states examined, eleven are highly likely to achieve the desired reduction in their suicide mortality rate by one third. The same number of countries shall succeed in view of the EU-wide target. In Ireland, Poland and the Netherlands, neither the country-specific nor the EU-wide threshold are likely to be met. Overall, a positive outcome is that the forecasted development in suicide mortality rate up to year 2030 does not show an increasing trend in any of the 27 member states. Considering harmful use of alcohol, by 2030, alcohol per capita consumption seems highly likely to decrease in sixteen of the 28 EU member states. Fourteen states are expected to reach the EU-wide target. In the Czech Republic, probability of reducing alcohol per capita consumption below the 2015 EU-level appears rather low.

Due to the substantial length of the forecast period, as well as the relative shortness of time series utilized in ARIMA models, these forecast results shall be perceived as merely indicative. However, they do highlight which member states seem to be progressing toward achieving the two respective health quality targets of Sustainable Development Goals and where more action may be required in order to attain them by year 2030.

Bibliography

[1] ANDRÉS, Antonio Rodríguez. Income Inequality, Unemployment, and Suicide: A Panel Data Analysis of 15 European Countries. *Applied Economics* [online]. 2005, 37(4), 439-451 [cit. 2018-05-23]. DOI: 10.1080/0003684042000295304. ISSN 0003-6846. Available at: http://www.tandfonline.com/doi/abs/10.1080/0003684042000295304

[2] BABOR, Thomas et al. *Alcohol: No Ordinary Commodity: Research and Public Policy*. 2nd ed. Oxford: Oxford University Press, 2010. ISBN 978-0-19-955114-9.

[3] BRITISH MEDICAL ASSOCIATION. *Reducing the Affordability of Alcohol: A Briefing from the BMA Board of Science* [online]. April 2012 [cit. 2019-02-18]. Available at: http://bmaopac.hosted.exlibrisgroup.com/exlibris/aleph/a23_1/apache_media/7A27VVN2V1JPQULT3B5H6LVMBY1V1D.pdf

[4] CROISSANT, Yves, MILLO, Giovanni. Panel Data Econometrics in R: The plm Package. *Journal of Statistical Software* [online]. 2008, 27(2), 1-43 [cit. 2019-03-01]. DOI: 10.18637/jss.v027.i02. ISSN 15487660. Available at: https://search.ebscohost.com/login.aspx?authtype=shib&custid=s1240919&direct=true&db=edselc&AN=edselc.2-52.0-48749091718&site=eds-live&scope=site&lang=cs

[5] DURKHEIM, Émile. *Suicide: a study in sociology*. New York: Free Press, c1951. ISBN 0-684-83632-7.

[6] EDWARDS, Griffith. Alcohol Policy and the Public Good. *Addiction* [online]. 1997, 92 (Supplement 1), 73-79 [cit. 2019-02-17]. ISSN 09652140. Available at: https://search.ebscohost.com/login.aspx?authtype=shib&custid=s1240919&direct=true&db=mdc&AN=9167291&site=eds-live&scope=site&lang=cs

[7] EUROPEAN COMMISSION. *Special Eurobarometer 341: Biotechnology* [online]. October 2010 [cit. 2019-04-17]. Available at: http://ec.europa.eu/commfrontoffice/publicopinion/archives/ebs/ebs_341_en.pdf

[8] GELMAN, Andrew, HILL, Jennifer. *Data Analysis Using Regression and Multilevel/Hierarchical Models*. New York: Cambridge University Press, 2007. ISBN 978-0-521-68689-1.

[9] GREENE, William H. *Econometric Analysis: International Edition*. 7th ed. Harlow: Pearson Education, 2012. ISBN 978-0-273-75356-8.

[10] HAMERMESH, Daniel S., SOSS, Neal M. An Economic Theory of Suicide. *Journal of Political Economy* [online]. 1974, 82(1), 83-98 [cit. 2018-05-23]. ISSN 00223808. Available at: https://www.jstor.org/stable/1830901?seq=1#page_scan_tab_contents

[11] HOLDEN, Erling, LINNERUD, Kristin, BANISTER, David. The Imperatives of Sustainable Development. *Sustainable Development* [online]. 2017, 25(3), 213-226 [cit. 2019-02-17]. DOI: 10.1002/sd.1647. ISSN 09680802. Available at: http://doi.wiley.com/10.1002/sd.1647

[12] HYNDMAN, Rob J., ATHANASOPOULOS, George. *Forecasting: Principles and Practice* [online]. 2nd ed. Melbourne: OTexts, 2018 [cit. 09-03-2019]. Available at: OTexts.com/fpp2

[13] HYNDMAN, Rob J., KHANDAKAR, Yeasmin. Automatic Time Series Forecasting: The forecast Package for R. *Journal of Statistical Software* [online]. 2008, 27(3) [cit. 2019-03-20]. ISSN 1548-7660. Available at: http://www.jstatsoft.org/v27/i03/paper

[14] MASARYK, Tomáš Garrigue. *Sebevražda hromadným jevem společenským moderní osvěty* [online]. Prague: Jan Laichter, 1904. Otázky a názory [cit. 2019-04-17]. Available at: http://kramerius4.nkp.cz/search/i.jsp?pid=uuid:3d8065a0-26ad-11e4-8e0d-005056827e51

[15] NELSON, Jon P. Alcohol Affordability and Alcohol Demand: Cross-Country Trends and Panel Data Estimates, 1975 to 2008. *Alcoholism: Clinical and Experimental Research* [online]. 2014, 38(4), 1167-1175 [cit. 2018-05-16]. DOI: 10.1111/acer.12345. ISSN 01456008. Available at: http://doi.wiley.com/10.1111/acer.12345

[16] NEUMAYER, Eric. Socioeconomic Factors and Suicide Rates at Large-unit Aggregate Levels: A Comment. *Urban Studies* [online]. 2003, 40(13), 2769-2776 [cit. 2019-02-21]. ISSN 00420980. Available at: https://search.ebscohost.com/login.aspx?authtype=shib&custid=s1240919&direct=true&db=edsjsr&AN=edsjsr.43100665&site=eds-live&scope=site&lang=cs

[17] OECD FAMILY DATABASE. *SF3.1: Marriage and Divorce Rates* [online]. 25 July 2018 [cit. 2019-03-03]. Available at: https://www.oecd.org/els/family/SF_3_1_Marriage_and_divorce_rates.pdf

[18] RABINOVICH, Lila, BRUTSCHER, Philipp-Bastian, DE VRIES, Han, TIESSEN, Jan, CLIFT, Jack, REDING, Anais. *The Affordability of Alcoholic Beverages in the European Union* [online]. Cambridge: RAND Europe, 2009 [cit. 2019-02-22]. Available at: http://ec.europa.eu/health/ph_determinants/life_style/alcohol/documents/alcohol_rand_en.pdf

[19] SKOG, Ole-Jørgen. The Collectivity of Drinking Cultures: A Theory of the Distribution of Alcohol Consumption. *British Journal of Addiction* [online]. 1985, 80(1), 83-99 [cit. 2019-02-17]. DOI: 10.1111/j.1360-0443.1985.tb05294.x. ISSN 13600443. Available at: https://search.ebscohost.com/login.aspx?authtype=shib&custid=s1240919&direct=true&db=edselc&AN=edselc.2-52.0-0021922810&site=eds-live&scope=site&lang=cs

[20] SKOG, Ole-Jørgen. The Historical Roots of Ledermann's Theory of the Distribution of Alcohol Consumption. *Contemporary Drug Problems* [online]. 2006, 33(1), 143-174 [cit. 2019-02-17]. ISSN 00914509. Available at: http://heinonline.org/HOL/Page?handle=hein.journals/condp33&div=13

[21] STACK, Steve. The Relationship of Female Labor Force Participation to Suicide: A Comparative Analysis. *Archives of Suicide Research* [online]. 1998, 4(3), 249-261 [cit. 2019-02-21]. DOI: 10.1080/13811119808258300. ISSN 1381-1118. Available at: http://www.tandfonline.com/doi/abs/10.1080/13811119808258300

[22] TEETOR, Paul. *R Cookbook*. Sebastopol: O'Reilly Media, 2011. ISBN 978-0-596-80915-7.

[23] UNITED NATIONS. *The Millennium Development Goals Report 2015* [online]. 16 September 2015a [cit. 2019-02-03]. ISBN 978-92-1-101320-7. Available at: http://www.un.org/millenniumgoals/2015_MDG_Report/pdf/MDG%202015%20rev%20(July%201).pdf

[24] UNITED NATIONS. *Transforming our world: the 2030 Agenda for Sustainable Development* [online]. New York: UN Publishing, 21 October 2015b [cit. 2018-05-22]. Available at: http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E

[25] UNITED NATIONS. *Work of the Statistical Commission pertaining to the 2030 Agenda for Sustainable Development* [online]. 10 July 2017 [cit. 2019-02-02]. Available at: https://undocs.org/A/RES/71/313

[26] UNITED NATIONS STATISTICS DIVISION. *Metadata for Indicator 3.4.2* [online]. 10 February 2017 [cit. 2019-02-07]. Available at: https://unstats.un.org/sdgs/metadata/files/Metadata-03-04-02.pdf

[27] WOOLDRIDGE, Jeffrey M. *Introductory Econometrics: A Modern Approach*. 6th ed. Boston: Cengage Learning, 2016. ISBN 978-1-305-27010-7.

[28] WORLD HEALTH ORGANIZATION. *Global Status Report on Alcohol and Health 2018* [online]. Geneva: World Health Organization, 2018 [cit. 2019-02-08]. ISBN 978-92-4-156563-9. Available at: https://apps.who.int/iris/bitstream/handle/10665/274603/9789241565639-eng.pdf?ua=1

[29] WORLD HEALTH ORGANIZATION. *Global Strategy to Reduce the Harmful Use of Alcohol* [online]. Geneva: World Health Organization, 2010 [cit. 2019-03-23]. ISBN 978-92-4-159993-1. Available at: https://apps.who.int/iris/bitstream/handle/10665/44395/9789241599931_eng.pdf?sequence=1

[30] WORLD HEALTH ORGANIZATION. *Preventing Suicide: A Global Imperative* [online]. Geneva: World Health Organization, 2014 [cit. 2019-03-22]. ISBN 978-92-4-156477-9. Available at: https://www.who.int/mental_health/suicide-prevention/world_report_2014/en/

[31] WORLD HEALTH ORGANIZATION REGIONAL OFFICE FOR EUROPE. *European Health Report 2018* [online]. Copenhagen: WHO Regional Office for Europe, 2018 [cit. 2019-03-22]. ISBN 9789289053433. Available at: http://www.euro.who.int/en/data-and-evidence/european-health-report/european-health-report-2018

[32] XUAN, Ziming, NELSON, Toben F., HEEREN, Timothy, BLANCHETTE, Jason, NELSON, David E., GRUENEWALD, Paul, NAIMI, Timothy S. Tax Policy, Adult Binge Drinking, and Youth Alcohol Consumption in the United States. *Alcoholism, Clinical and Experimental Research* [online]. 2013, 37(10), 1713-1719 [cit. 2019-02-18]. DOI: 10.1111/acer.12152. ISSN 15300277. Available at: https://search.ebscohost.com/login.aspx?authtype=shib&custid=s1240919&direct=true&db=mdc&AN=23711219&site=eds-live&scope=site&lang=cs

[33] YANG, Bijou. The Economy and Suicide: A Time-Series Study of the U.S.A. *American Journal of Economics & Sociology* [online]. 1992, 51(1), 87-99

[cit. 2019-02-21]. DOI: 10.1111/j.1536-7150.1992.tb02512.x. ISSN 00029246. Available at:
https://search.ebscohost.com/login.aspx?authtype=shib&custid=s1240919&direct=true&db=sih&AN=9202172442&site=eds-live&scope=site&lang=cs

List of Appendices

Appendices

Appendix 1: Regression results – Suicide mortality rate (table)

	Dependent variable: ln(suicide rate)			
	Pooled OLS	FD	FE	RE
GDP per capita	-0.007***	0.016***	-0.008***	-0.007***
	(0.001)	(0.005)	(0.003)	(0.002)
Economic growth	0.036***	-0.002	-0.002	-0.002
	(0.007)	(0.002)	(0.002)	(0.002)
Unemployment rate	0.010*	0.008**	0.009***	0.009***
	(0.006)	(0.003)	(0.002)	(0.002)
Fertility rate	0.432***	-0.130	-0.173**	-0.140**
	(0.114)	(0.111)	(0.072)	(0.072)
Divorce rate	0.288***	0.071***	0.084***	0.098***
	(0.030)	(0.023)	(0.021)	(0.021)
Female labour participation rate	0.004	0.002	-0.003	-0.002
	(0.004)	(0.005)	(0.003)	(0.003)
Alcohol per capita consumption	0.039***	0.001	-0.019***	-0.018***
	(0.010)	(0.007)	(0.005)	(0.005)
1997 fixed effect	-0.026	-	0.006	0.005
	(0.120)		(0.033)	(0.034)
1998 fixed effect	-0.026	-0.029	-0.022	-0.023
	(0.120)	(0.025)	(0.034)	(0.034)
1999 fixed effect	0.004	-0.058	-0.046	-0.048
	(0.120)	(0.044)	(0.034)	(0.035)
2000 fixed effect	-0.113	-0.068	-0.036	-0.043
	(0.121)	(0.062)	(0.035)	(0.035)
2001 fixed effect	-0.068	-0.076	-0.050	-0.057
	(0.121)	(0.080)	(0.035)	(0.036)
2002 fixed effect	-0.072	-0.062	-0.043	-0.051
	(0.121)	(0.098)	(0.036)	(0.036)
2003 fixed effect	-0.126	-0.092	-0.077**	-0.087**
	(0.121)	(0.116)	(0.037)	(0.036)

2004 fixed effect	-0.204*	-0.110	-0.088**	-0.101***
	(0.121)	(0.135)	(0.038)	(0.037)
2005 fixed effect	-0.249**	-0.141	-0.117***	-0.132***
	(0.121)	(0.153)	(0.039)	(0.038)
2006 fixed effect	-0.342***	-0.166	-0.127***	-0.146***
	(0.122)	(0.171)	(0.041)	(0.040)
2007 fixed effect	-0.396***	-0.212	-0.154***	-0.175***
	(0.122)	(0.189)	(0.043)	(0.041)
2008 fixed effect	-0.244**	-0.181	-0.149***	-0.169***
	(0.123)	(0.208)	(0.043)	(0.041)
2009 fixed effect	0.035	-0.133	-0.179***	-0.192***
	(0.138)	(0.229)	(0.045)	(0.044)
2010 fixed effect	-0.271**	-0.152	-0.200***	-0.218***
	(0.122)	(0.246)	(0.042)	(0.040)
2011 fixed effect	-0.281**	-0.142	-0.199***	-0.217***
	(0.121)	(0.263)	(0.042)	(0.040)
2012 fixed effect	-0.180	-0.114	-0.198***	-0.215***
	(0.124)	(0.282)	(0.042)	(0.040)
2013 fixed effect	-0.227*	-0.133	-0.238***	-0.254***
	(0.122)	(0.300)	(0.041)	(0.040)
2014 fixed effect	-0.279**	-0.111	-0.215***	-0.234***
	(0.121)	(0.318)	(0.042)	(0.040)
Constant	0.724***	-0.019	-	2.973***
	(0.273)	(0.018)		(0.211)
Observations	494	468	494	494
R^2	0.383	0.100	0.530	0.506
Adjusted R^2	0.350	0.052	0.477	0.480
F statistic	11.617***	2.062***	19.959***	479.255***
	(df = 25; 468)	(df = 24; 443)	(df = 25; 443)	(df = 25)

Note: *p<0.1; **p<0.05; ***p<0.01
Standard errors reported in parentheses.

Appendix 2: Regression results with robust standard errors – Suicide mortality rate (table)

	Dependent variable: ln(suicide rate)			
	Pooled OLS	FD	FE	RE
GDP per capita	-0.007* (0.004)	0.016** (0.008)	-0.008 (0.006)	-0.007** (0.003)
Economic growth	0.036*** (0.011)	-0.002 (0.002)	-0.002 (0.002)	-0.002 (0.002)
Unemployment rate	0.010 (0.016)	0.008*** (0.002)	0.009* (0.005)	0.009* (0.005)
Fertility rate	0.432 (0.348)	-0.130 (0.096)	-0.173 (0.207)	-0.140 (0.200)
Divorce rate	0.288** (0.118)	0.071* (0.042)	0.084 (0.059)	0.098 (0.061)
Female labour participation rate	0.004 (0.015)	0.002 (0.004)	-0.003 (0.006)	-0.002 (0.006)
Alcohol per capita consumption	0.039 (0.025)	0.001 (0.006)	-0.019* (0.011)	-0.018* (0.010)
1997 fixed effect	-0.026 (0.030)	-	0.006 (0.017)	0.005 (0.016)
1998 fixed effect	-0.026 (0.041)	-0.029 (0.021)	-0.022 (0.020)	-0.023 (0.019)
1999 fixed effect	0.004 (0.050)	-0.058* (0.035)	-0.046* (0.026)	-0.048** (0.024)
2000 fixed effect	-0.113** (0.048)	-0.068 (0.051)	-0.036 (0.029)	-0.043* (0.025)
2001 fixed effect	-0.068 (0.050)	-0.076 (0.055)	-0.050 (0.039)	-0.057* (0.032)
2002 fixed effect	-0.072 (0.054)	-0.062 (0.076)	-0.043 (0.051)	-0.051 (0.041)
2003 fixed effect	-0.126** (0.060)	-0.092 (0.089)	-0.077 (0.052)	-0.087** (0.043)

2004 fixed effect	-0.204***	-0.110	-0.088	-0.101**
	(0.060)	(0.102)	(0.059)	(0.047)
2005 fixed effect	-0.249***	-0.141	-0.117*	-0.132**
	(0.071)	(0.117)	(0.065)	(0.052)
2006 fixed effect	-0.342***	-0.166	-0.127*	-0.146**
	(0.088)	(0.128)	(0.076)	(0.058)
2007 fixed effect	-0.396***	-0.212	-0.154*	-0.175***
	(0.096)	(0.138)	(0.080)	(0.058)
2008 fixed effect	-0.244**	-0.181	-0.149*	-0.169***
	(0.111)	(0.154)	(0.078)	(0.061)
2009 fixed effect	0.035	-0.133	-0.179***	-0.192***
	(0.136)	(0.165)	(0.066)	(0.054)
2010 fixed effect	-0.271***	-0.152	-0.200**	-0.218***
	(0.073)	(0.179)	(0.078)	(0.061)
2011 fixed effect	-0.281***	-0.142	-0.199***	-0.217***
	(0.084)	(0.182)	(0.076)	(0.059)
2012 fixed effect	-0.180*	-0.114	-0.198***	-0.215***
	(0.095)	(0.197)	(0.070)	(0.056)
2013 fixed effect	-0.227**	-0.133	-0.238***	-0.254***
	(0.095)	(0.209)	(0.076)	(0.064)
2014 fixed effect	-0.279***	-0.111	-0.215**	-0.234***
	(0.083)	(0.221)	(0.086)	(0.068)
Constant	0.724	-0.019	-	2.973***
	(0.835)	(0.015)		(0.407)
Observations	494	468	494	494
R^2	0.383	0.100	0.530	0.506
Adjusted R^2	0.350	0.052	0.477	0.480

Note: *p<0.1; **p<0.05; ***p<0.01
Robust standard errors reported in parentheses.

Appendix 3: Regression results – Alcohol per capita consumption (table)

	Dependent variable: ln(alcohol per capita consumption)			
	Pooled OLS	FD	FE	RE
ln(real per capita income)	0.021	0.650***	0.802***	0.641***
	(0.029)	(0.091)	(0.046)	(0.044)
ln(real alcohol price index)	-0.022	-0.335***	-0.142***	-0.097*
	(0.118)	(0.096)	(0.054)	(0.057)
2001 fixed effect	0.007	-	-0.013	-0.009
	(0.055)		(0.020)	(0.022)
2002 fixed effect	0.009	-0.003	-0.030	-0.023
	(0.056)	(0.015)	(0.020)	(0.022)
2003 fixed effect	0.027	0.010	-0.032	-0.021
	(0.056)	(0.025)	(0.021)	(0.022)
2004 fixed effect	0.040	0.007	-0.047**	-0.031
	(0.056)	(0.036)	(0.021)	(0.022)
2005 fixed effect	0.043	-0.005	-0.071***	-0.049**
	(0.056)	(0.046)	(0.021)	(0.023)
2006 fixed effect	0.058	-0.009	-0.090***	-0.061***
	(0.056)	(0.056)	(0.022)	(0.023)
2007 fixed effect	0.073	-0.010	-0.107***	-0.073***
	(0.057)	(0.067)	(0.023)	(0.024)
2008 fixed effect	0.052	-0.015	-0.127***	-0.094***
	(0.058)	(0.077)	(0.024)	(0.025)
2009 fixed effect	0.007	-0.004	-0.120***	-0.099***
	(0.060)	(0.087)	(0.024)	(0.025)
2010 fixed effect	0.009	0.0002	-0.127***	-0.104***
	(0.061)	(0.098)	(0.024)	(0.026)
2011 fixed effect	0.009	-0.002	-0.139***	-0.114***
	(0.062)	(0.108)	(0.025)	(0.026)
2012 fixed effect	0.006	0.011	-0.136***	-0.112***
	(0.063)	(0.119)	(0.025)	(0.027)
2013 fixed effect	-0.016	0.001	-0.156***	-0.134***
	(0.065)	(0.129)	(0.026)	(0.028)

2014 fixed effect	-0.010	0.003	-0.166***	-0.141***
	(0.066)	(0.139)	(0.027)	(0.028)
2015 fixed effect	-0.019	-0.018	-0.198***	-0.169***
	(0.066)	(0.150)	(0.027)	(0.029)
Constant	2.228***	-0.005		-3.737***
	(0.432)	(0.011)		(0.429)
Observations	432	405	432	432
R^2	0.020	0.211	0.496	0.399
Adjusted R^2	-0.020	0.178	0.440	0.375
F statistic	0.506	6.473***	22.42***	275.348***
	(df = 17; 414)	(df = 16; 388)	(df = 17; 388)	(df = 17)
Note:				*p<0.1; **p<0.05; ***p<0.01
				Standard errors reported in parentheses.

Appendix 4: Regression results with robust standard errors – Alcohol per capita consumption (table)

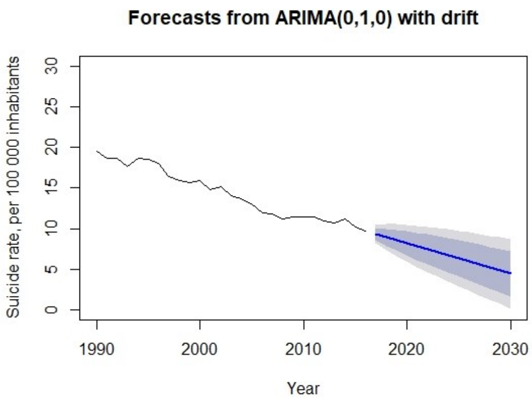
	Dependent variable: ln(alcohol per capita consumption)			
	Pooled OLS	FD	FE	RE
ln(real per capita income)	0.021	0.650***	0.802***	0.641***
	(0.064)	(0.124)	(0.105)	(0.093)
ln(real alcohol price index)	-0.022	-0.335***	-0.142	-0.097
	(0.255)	(0.065)	(0.126)	(0.120)
2001 fixed effect	0.007	-	-0.013	-0.009
	(0.013)		(0.011)	(0.011)
2002 fixed effect	0.009	-0.003	-0.030*	-0.023
	(0.023)	(0.014)	(0.018)	(0.018)
2003 fixed effect	0.027	0.010	-0.032*	-0.021
	(0.030)	(0.022)	(0.018)	(0.019)
2004 fixed effect	0.040	0.007	-0.047**	-0.031
	(0.036)	(0.031)	(0.023)	(0.023)
2005 fixed effect	0.043	-0.005	-0.071***	-0.049**
	(0.038)	(0.044)	(0.021)	(0.021)
2006 fixed effect	0.058	-0.009	-0.090***	-0.061**
	(0.048)	(0.056)	(0.029)	(0.029)
2007 fixed effect	0.073	-0.010	-0.107***	-0.073**
	(0.053)	(0.065)	(0.031)	(0.030)
2008 fixed effect	0.052	-0.015	-0.127***	-0.094***
	(0.062)	(0.076)	(0.034)	(0.034)
2009 fixed effect	0.007	-0.004	-0.120***	-0.099**
	(0.072)	(0.083)	(0.037)	(0.039)
2010 fixed effect	0.009	0.0002	-0.127***	-0.104***
	(0.075)	(0.092)	(0.037)	(0.038)
2011 fixed effect	0.009	-0.002	-0.139***	-0.114***
	(0.081)	(0.101)	(0.038)	(0.040)
2012 fixed effect	0.006	0.011	-0.136***	-0.112***
	(0.089)	(0.111)	(0.042)	(0.043)

2013 fixed effect	-0.016	0.001	-0.156***	-0.134***
	(0.099)	(0.122)	(0.045)	(0.047)
2014 fixed effect	-0.010	0.003	-0.166***	-0.141***
	(0.101)	(0.133)	(0.046)	(0.047)
2015 fixed effect	-0.019	-0.018	-0.198***	-0.169***
	(0.103)	(0.144)	(0.051)	(0.052)
Constant	2.228***	-0.005		-3.737***
	(1.009)	(0.010)		(1.146)
Observations	432	405	432	432
R^2	0.020	0.211	0.496	0.399
Adjusted R^2	-0.020	0.178	0.440	0.375

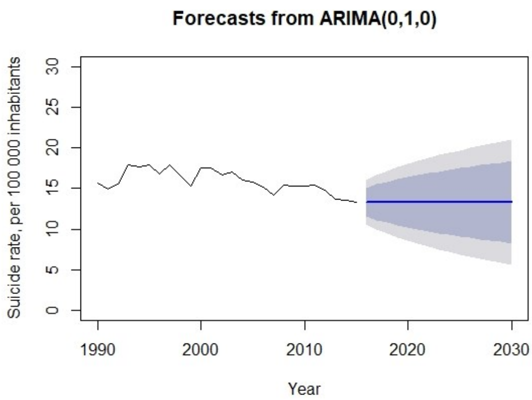
Note: *p<0.1; **p<0.05; ***p<0.01
Robust standard errors reported in parentheses.

Appendix 5: ARIMA forecast – Suicide mortality rate, by country (graph)

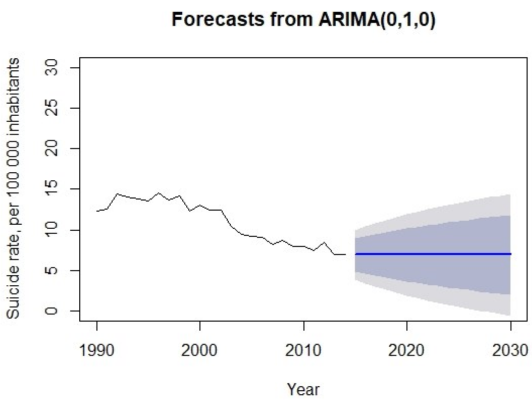
Suicide mortality rate: AUT



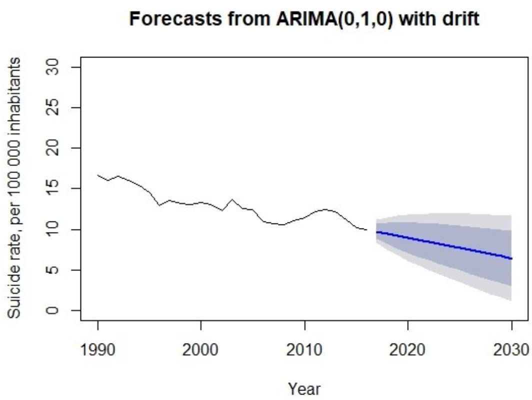
Suicide mortality rate: BEL



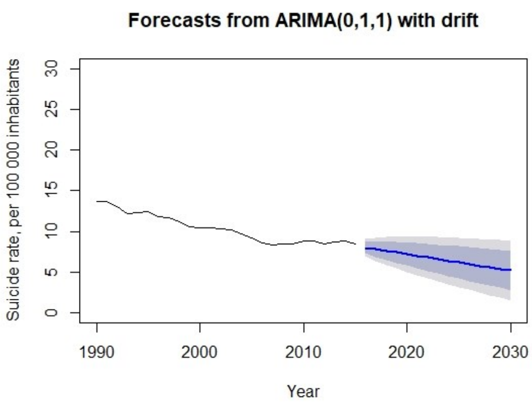
Suicide mortality rate: BGR



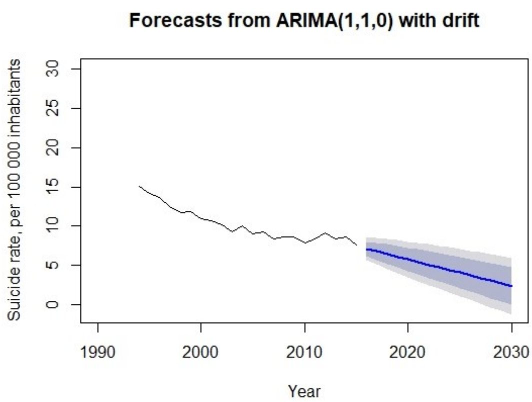
Suicide mortality rate: CZE



Suicide mortality rate: DEU



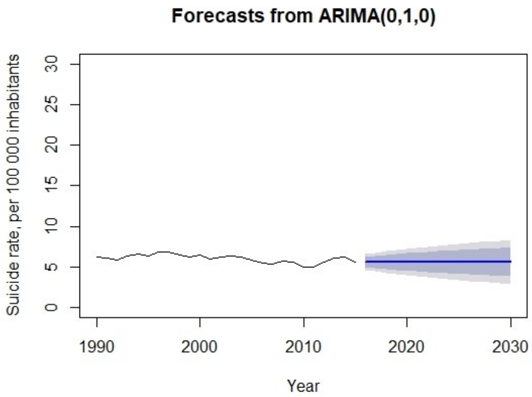
Suicide mortality rate: DNK



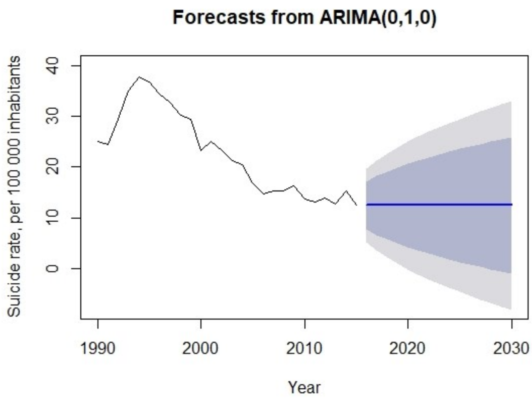
Note: Blue line depicts point forecast. Dark grey area depicts 80% confidence interval. Light grey area depicts 95% confidence interval.

Age-standardized suicide mortality rate reported.

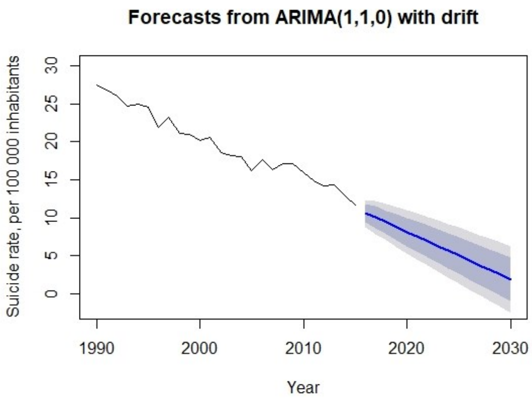
Suicide mortality rate: ESP



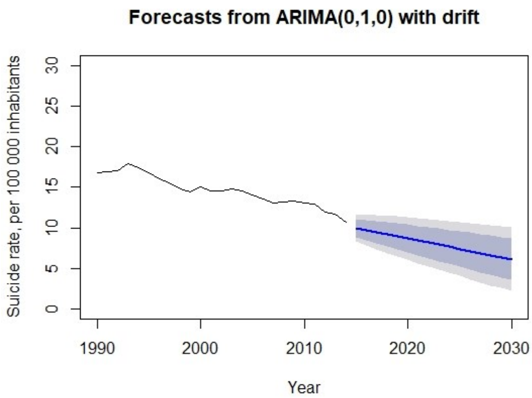
Suicide mortality rate: EST



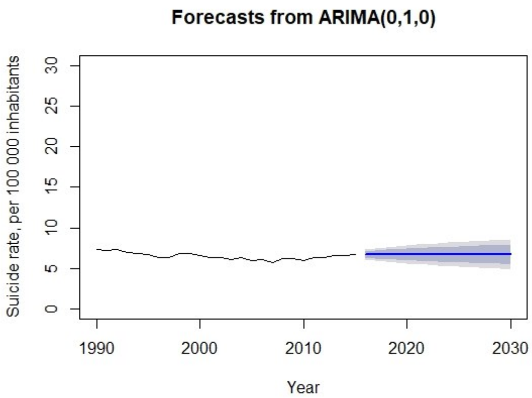
Suicide mortality rate: FIN



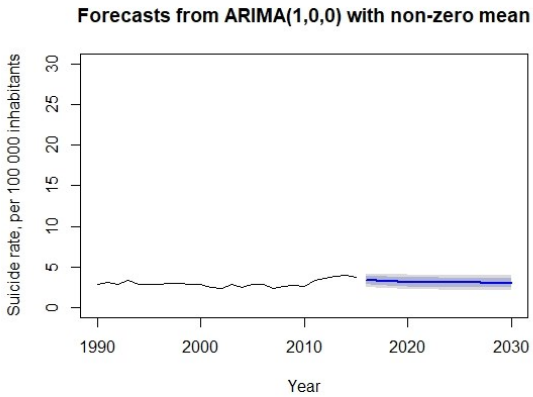
Suicide mortality rate: FRA



Suicide mortality rate: GBR



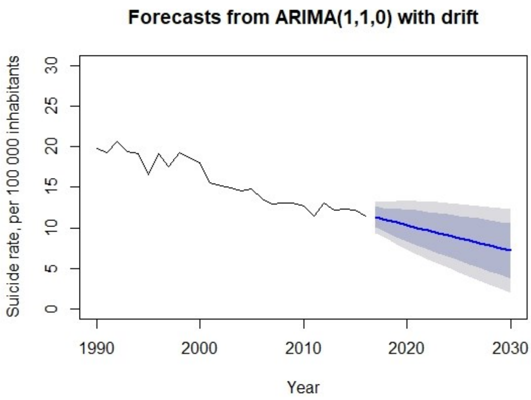
Suicide mortality rate: GRC



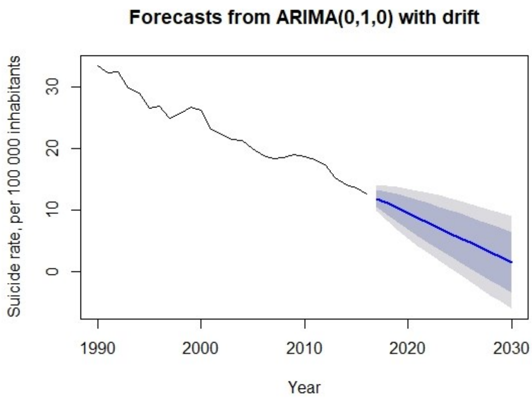
Note: Blue line depicts point forecast. Dark grey area depicts 80% confidence interval. Light grey area depicts 95% confidence interval.

Age-standardized suicide mortality rate reported.

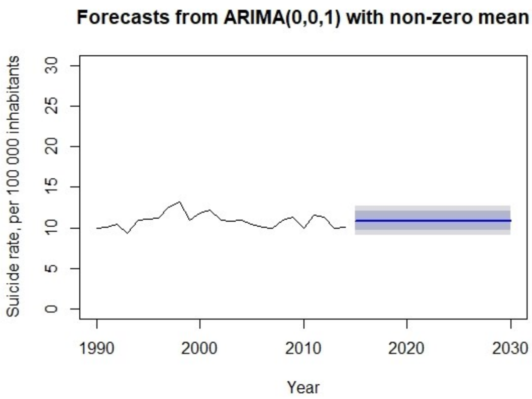
Suicide mortality rate: HRV



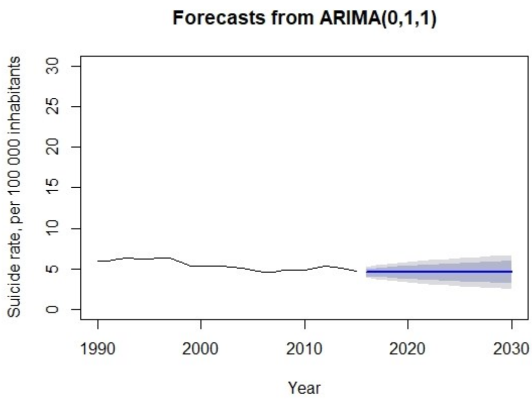
Suicide mortality rate: HUN



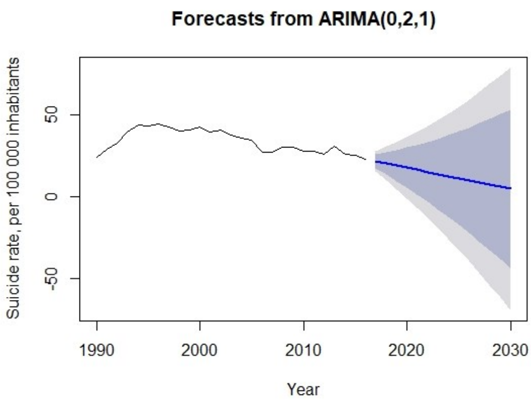
Suicide mortality rate: IRL



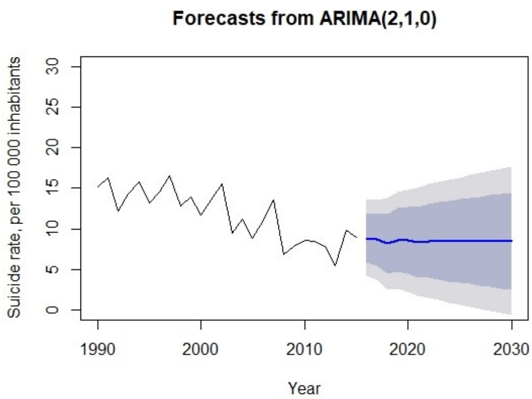
Suicide mortality rate: ITA



Suicide mortality rate: LTU



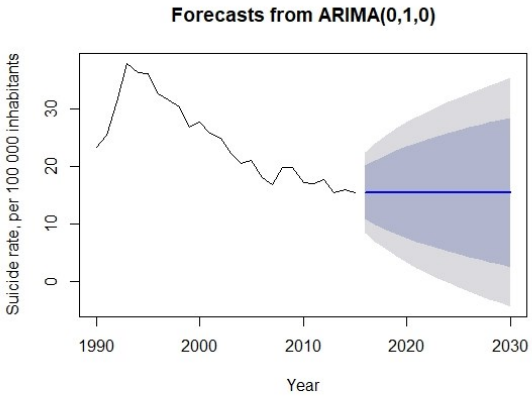
Suicide mortality rate: LUX



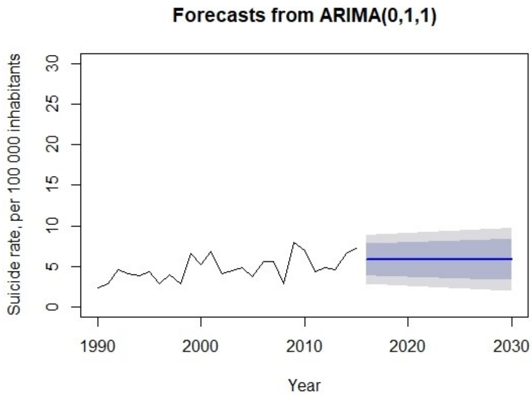
Note: Blue line depicts point forecast. Dark grey area depicts 80% confidence interval. Light grey area depicts 95% confidence interval.

Age-standardized suicide mortality rate reported.

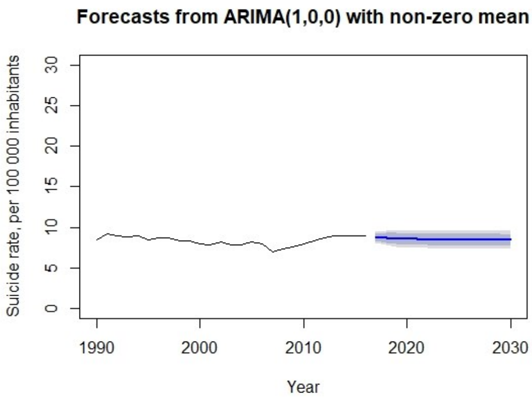
Suicide mortality rate: LVA



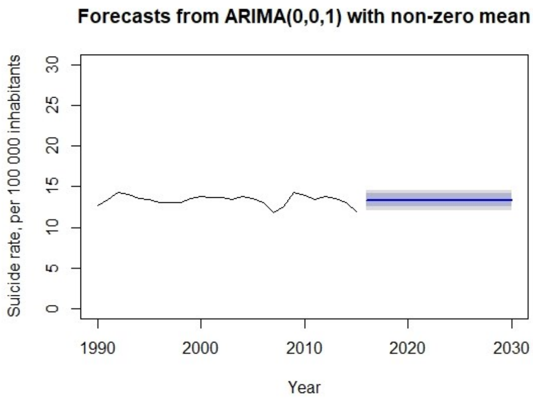
Suicide mortality rate: MLT



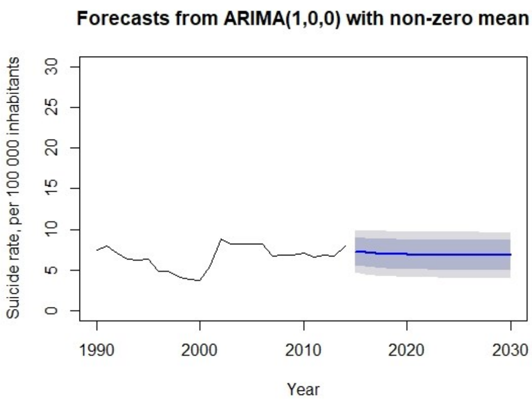
Suicide mortality rate: NLD



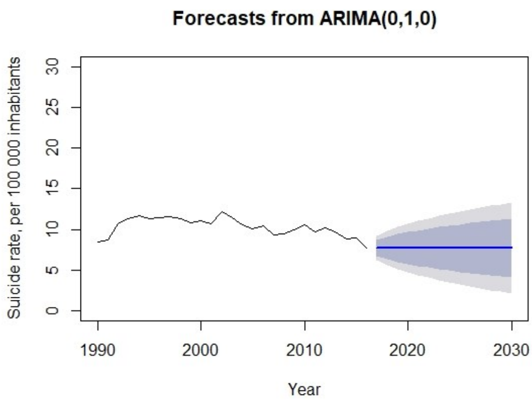
Suicide mortality rate: POL



Suicide mortality rate: PRT



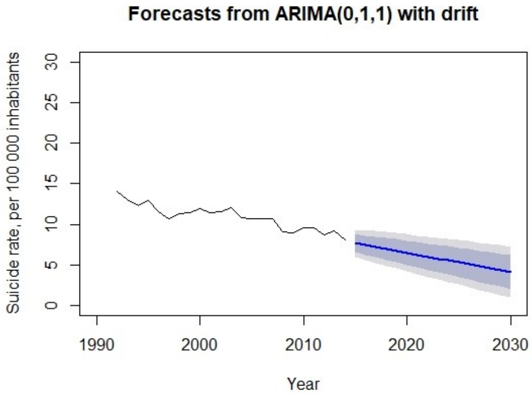
Suicide mortality rate: ROU



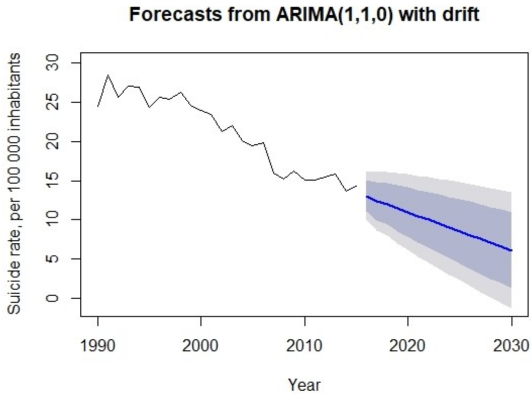
Note: Blue line depicts point forecast. Dark grey area depicts 80% confidence interval. Light grey area depicts 95% confidence interval.

Age-standardized suicide mortality rate reported.

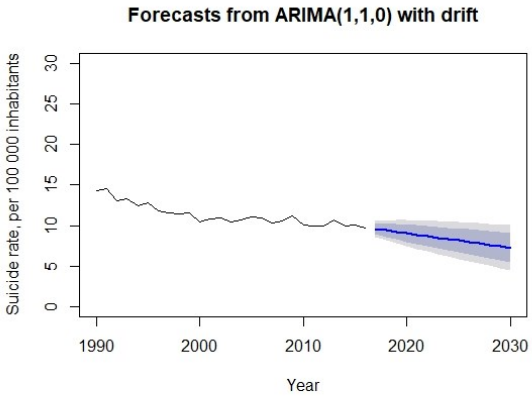
Suicide mortality rate: SVK



Suicide mortality rate: SVN



Suicide mortality rate: SWE

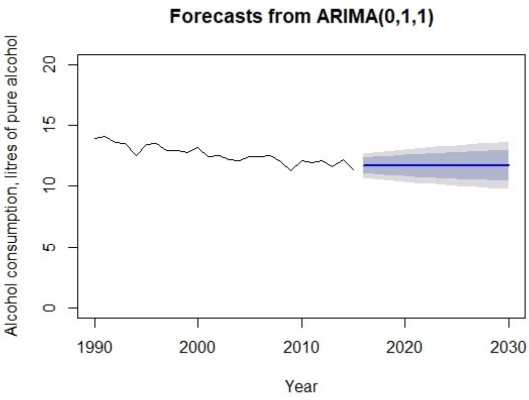


Note: Blue line depicts point forecast. Dark grey area depicts 80% confidence interval. Light grey area depicts 95% confidence interval.

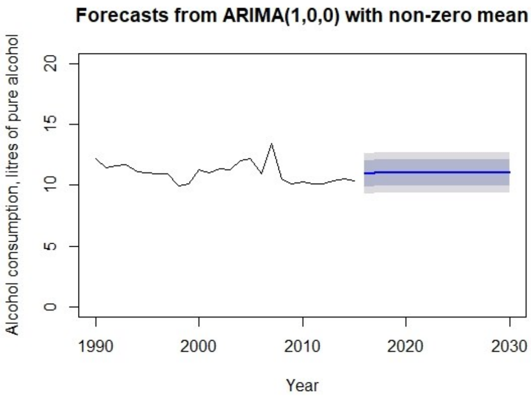
Age-standardized suicide mortality rate reported.

Appendix 6: ARIMA forecast – Alcohol per capita consumption, by country (graph)

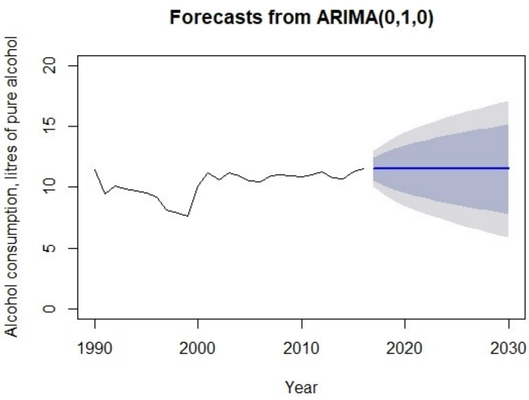
Alcohol per capita consumption: AUT



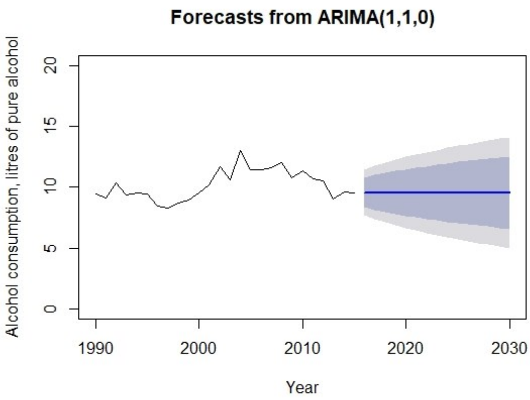
Alcohol per capita consumption: BEL



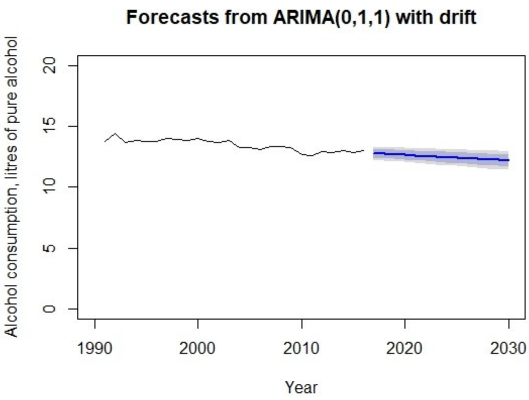
Alcohol per capita consumption: BGR



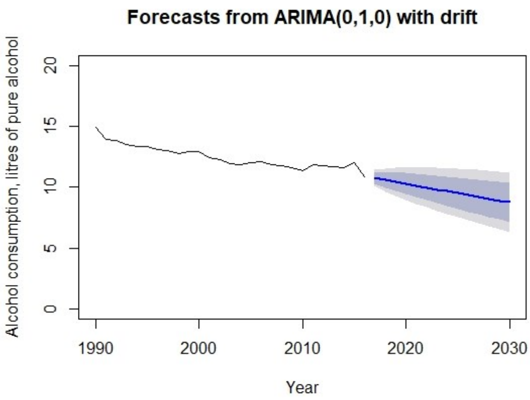
Alcohol per capita consumption: CYP



Alcohol per capita consumption: CZE

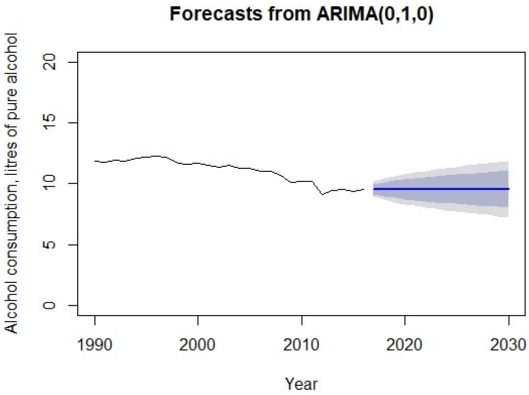


Alcohol per capita consumption: DEU

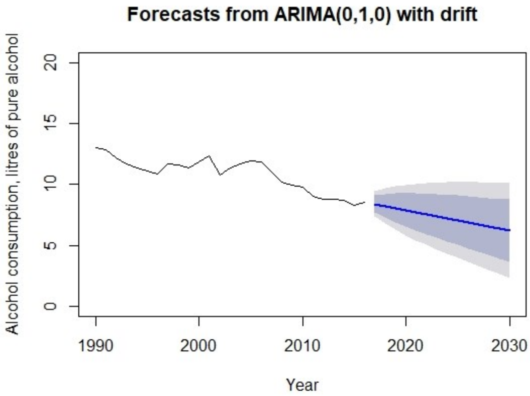


Note: Blue line depicts point forecast. Dark grey area depicts 80% confidence interval. Light grey area depicts 95% confidence interval.

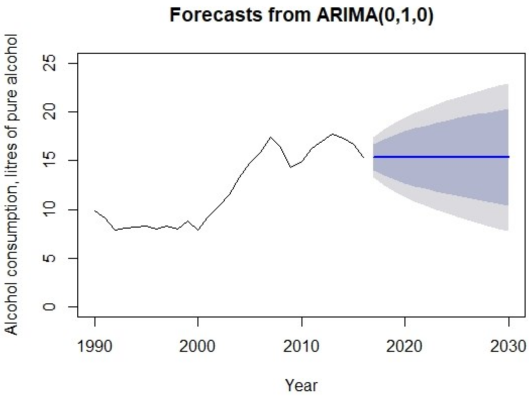
Alcohol per capita consumption: DNK



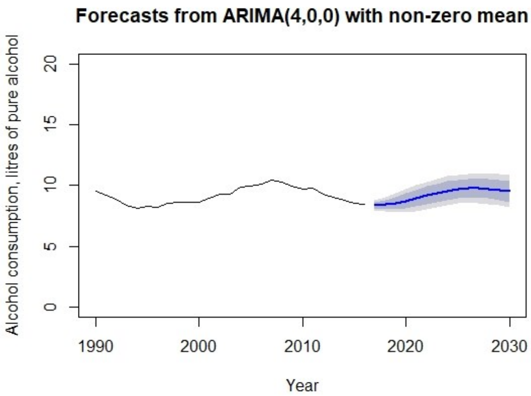
Alcohol per capita consumption: ESP



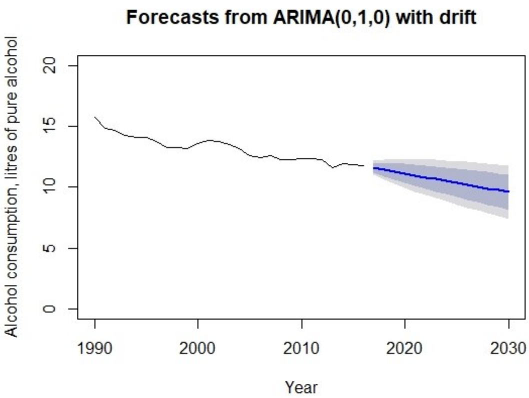
Alcohol per capita consumption: EST



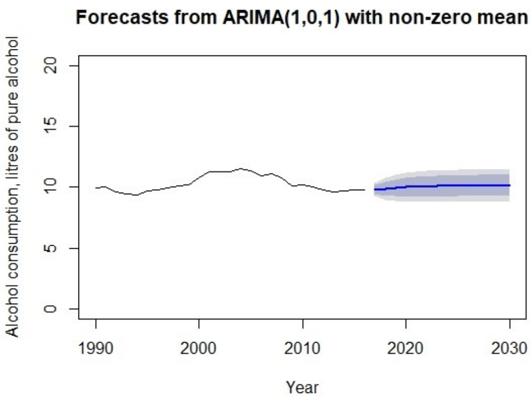
Alcohol per capita consumption: FIN



Alcohol per capita consumption: FRA

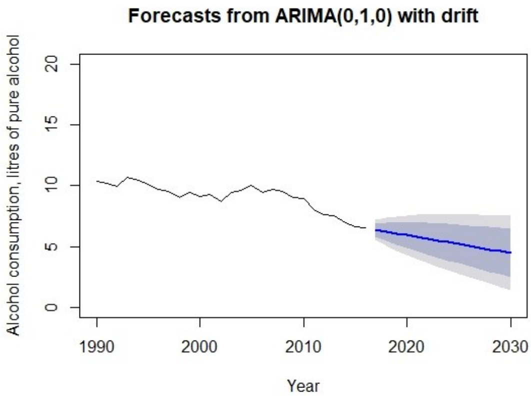


Alcohol per capita consumption: GBR

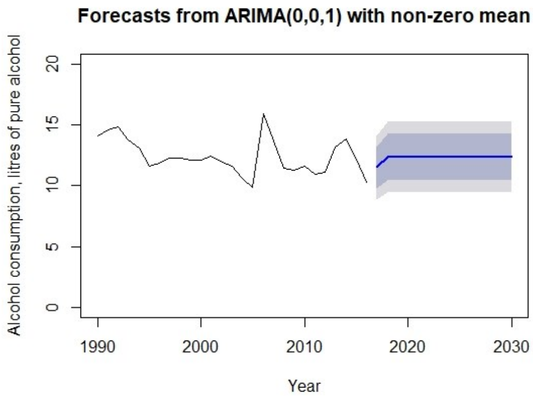


Note: Blue line depicts point forecast. Dark grey area depicts 80% confidence interval. Light grey area depicts 95% confidence interval.

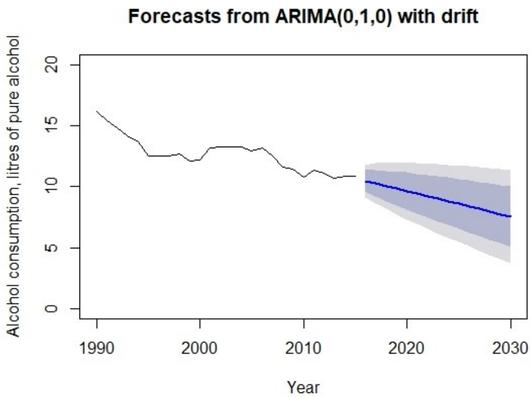
Alcohol per capita consumption: GRC



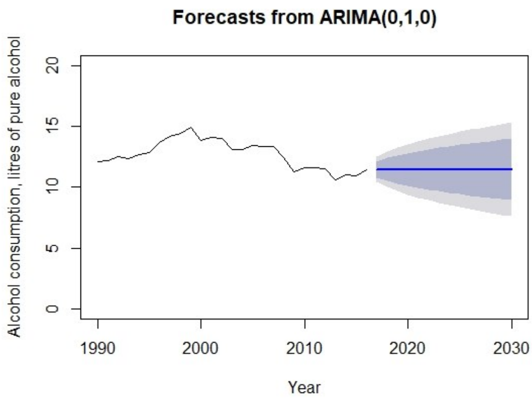
Alcohol per capita consumption: HRV



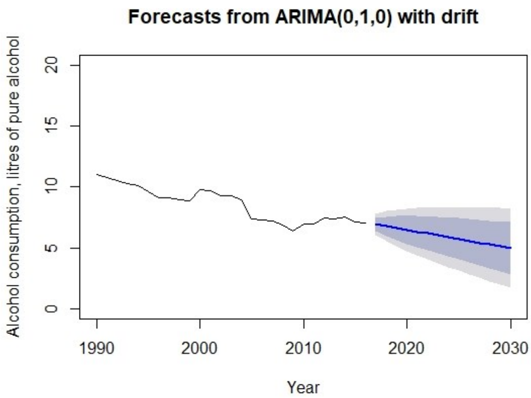
Alcohol per capita consumption: HUN



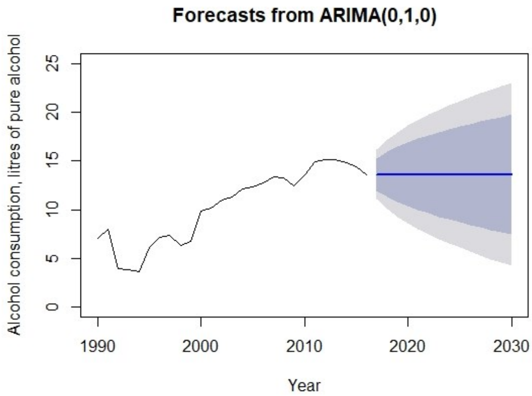
Alcohol per capita consumption: IRL



Alcohol per capita consumption: ITA

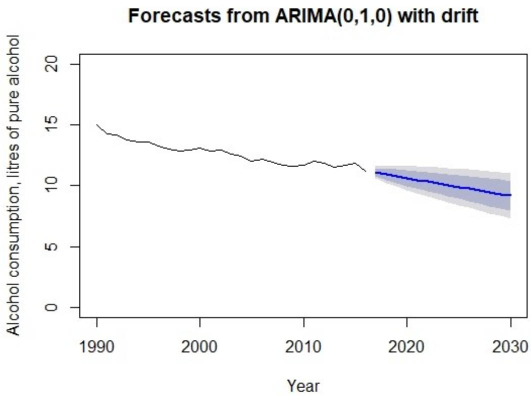


Alcohol per capita consumption: LTU

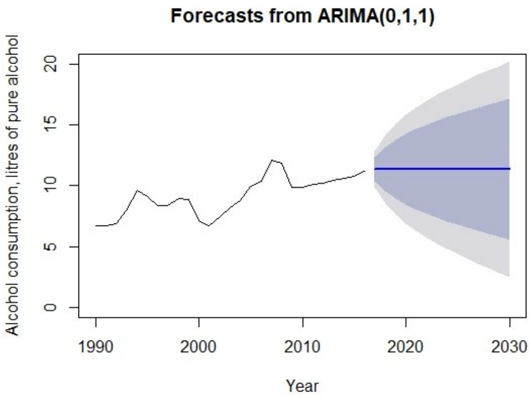


Note: Blue line depicts point forecast. Dark grey area depicts 80% confidence interval. Light grey area depicts 95% confidence interval.

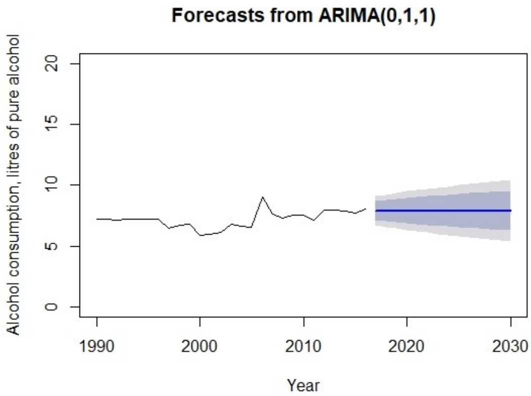
Alcohol per capita consumption: LUX



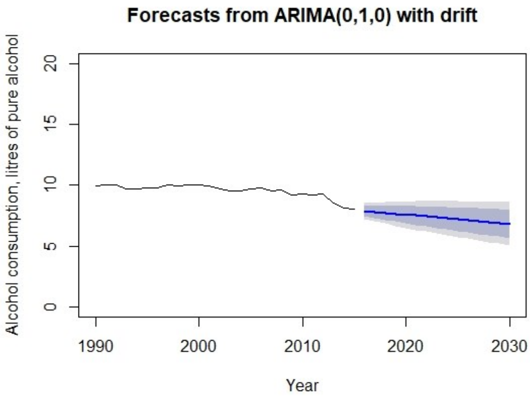
Alcohol per capita consumption: LVA



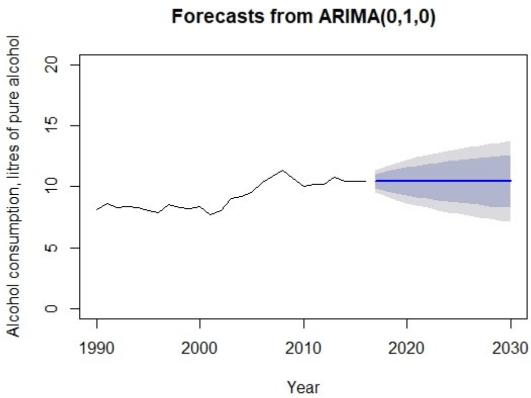
Alcohol per capita consumption: MLT



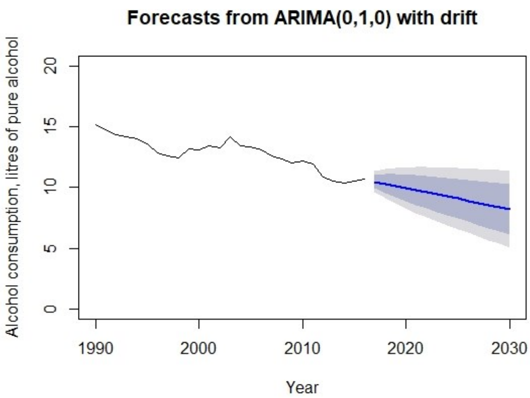
Alcohol per capita consumption: NLD



Alcohol per capita consumption: POL

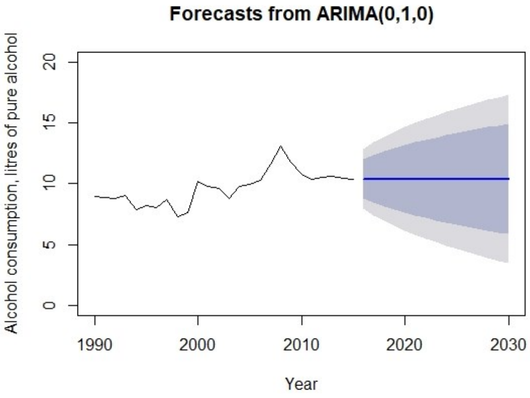


Alcohol per capita consumption: PRT

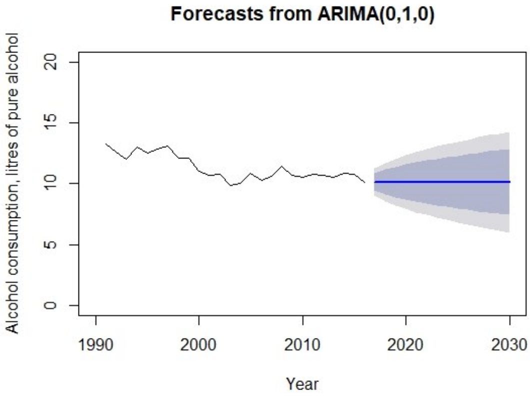


Note: Blue line depicts point forecast. Dark grey area depicts 80% confidence interval. Light grey area depicts 95% confidence interval.

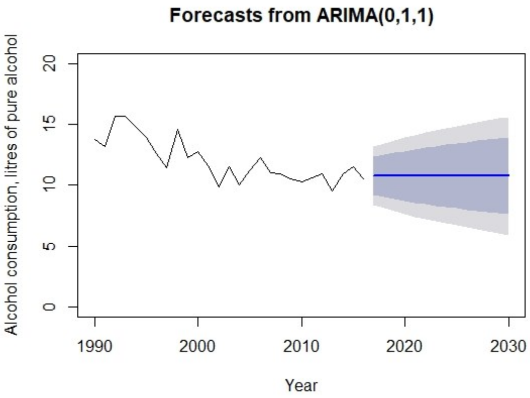
Alcohol per capita consumption: ROU



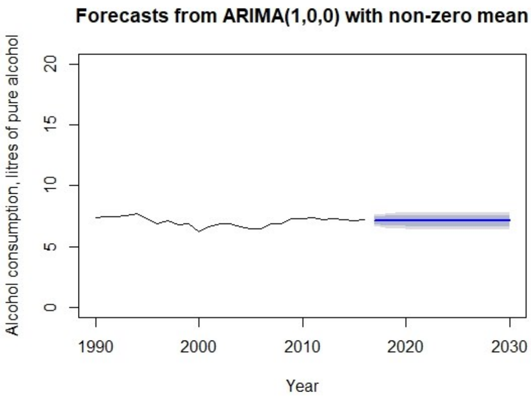
Alcohol per capita consumption: SVK



Alcohol per capita consumption: SVN



Alcohol per capita consumption: SWE



Note: Blue line depicts point forecast. Dark grey area depicts 80% confidence interval. Light grey area depicts 95% confidence interval.