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The effect of sugar taxation on sugar consumption

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Table of Contents

1 Introduction

The western diet, which has spread to all parts of the world, consists of more and more sugar and added sweeteners and these are forming a danger to health (Bray et al., 2014). This diet is driven by efficiency, which leads to a big increase in the availability of high calorie foods and that at a low cost. These cheap and high calorie foods contain lots of salt, sugar, saturated fats and trans fats (Lustig et al., 2012; Branca et al., 2019). Not only is the western diet more efficiency focused, but next to that the demand for meat, dairy products and sugar sweetened drinks has drastically risen (Global panel on Agriculture and Food Systems for Nutrition, 2016). All of this has led to malnutrition, in the form of an excessive and imbalanced diet (Branca et al., 2019). This unhealthy diet needs to be changed, because it has a big burden, both on the health of the population as financially.

This sugar rich diet has led to a steep rise in chronic non-communicable diseases (for example diseases like, cancer, diabetes, mental and hearth diseases) and those diseases are responsible for almost 70% of all deaths in the world (WHO, 2022; WHO, 2021; Lustig et al., 2012). Although the term "western diet" suggests that it is solely an issue for developed countries, this is untrue since the diet has spread to all parts of the world. Thus, it cannot be seen as a disease of the rich and developed countries anymore. Nowadays it is even the case that the burden of these non-communicable diseases (NCDs) is even higher in non-developed countries. They have an ill-health system and therefore it is more difficult for them to treat these NCDs but also to treat infective and non-infective diseases, which given an extra burden (Boutayeb et al., 2005).

This sugar rich western diet does not only have high burden on the health of society but has also economic costs. NCDs are estimated to cost more than 30 trillion US dollars in the next two decades (the cost here is measured in the form of diagnosis, procedures drugs, care, nonmedical cost and the decrease in labor, funds and other factors at production level) (Rao et al., 2019). This prediction shows the burden in the future, but there is already a large burden nowadays. A good example to show this burden are the worldwide costs of cardiovascular diseases. In 2015 the costs here were around 210 billion euros (this number includes health care costs, but also productivity losses and informal care) (WHO, 2022; Timmis et al., 2019).

This concludes that the excessive amount of sugar intake costs both financially and on the wellbeing of society. In order to counter this, multiple countries have introduced, or have thought of introducing, a sugar tax as a policy to lower the amount of sugar consumed.

1.1 Research questions

This study gives more insight into the effectiveness of sugar taxation. This is done by addressing the following research question: What is the effect of sugar taxation on the consumption of sugar? What is the effect of sugar taxation the consumption of Sugar Sweetened Beverages? And does the tax form influence the effect of sugar taxation on the consumption of sugar?

These questions lead to the following three hypotheses:

Hypothesis 1:

- Sugar taxation does lower the amount of sugar consumed in a country.

Hypothesis 2:

- Sugar taxation does lower the amount of sugar sweetened beverages consumed in a country.

Hypothesis 3

- the form of taxation does matter for reducing the sugar consumption.

1.2 Value of the research for science and policy

Previous research mostly shows that sugar taxation, which is almost solely used on Sugar Sweetened Beverages (SSB), has a negative effect on the consumption of SSBs and thus the expected effect. However, there is also some literature that does not agree with this and does not show a negative effect on SSB consumption. Some countries, with as most famous example Denmark, have even stopped their sugar taxation. This study tries to get more consensus on whether sugar taxation is an effective way to lower the amount of sugar consumed. Therefore, it looks broader than only looking at the effect of the taxation on only SSB consumption, but it also uses sugar consumption as the dependent variable and by looking at all countries that did implement a form of sugar taxation in the period from 2004 till 2019. This gives more insight into the effect of the taxation on the total amount of sugar consumed and whether people do not simply get their sugar intake in another way. This is done by using an event study. The reason this study uses an event study is because an event study is able to look at the effect that an event has, in this case an implementation of sugar taxation, on the dependent variable. This all gives a more complete view of the effectiveness of the sugar taxation, since the most important aspect from a health and economical perspective is the quantity of sugar consumed and not in which form the sugar is consumed.

2 Literature review

2.1 Introduction

Taxation is an often-used policy instrument in order to lessen the consumption of health declining products. This is for example also done with regards to alcohol and tobacco (Chaloupka et al., 2010; Cnossen 2007). Most of the academic literature shows that alcohol and/or tobacco tax is an effective way to improve public health (Chaloupka et al., 2010; van Baal et al., 2007; Elder et al., 2010). However, the problem that arises is that the companies undermine the policy and find loopholes and that therefore the policy will be ineffective (Ross et al., 2017; López-Nicolás et al., 2012). For sugar consumption, there is less consensus on whether taxation would be an effective policy tool.

2.2 Brief history of the harms of sugar consumption

Sugar was regarded as a spice when it first entered Europe in the 11th century. Not only was it seen as a spice but also as a spice that had considerable medicinal properties. Therefore, it was commonly prescribed till into the 17th century. However, around that time the first signs of sugar being unhealth were uncovered. This was first done in 1606 by the French physician du Chesne and about half a century later Monsieur Garencičres found that sugar was the cause of tuberculosis (Clay, 1999).

Although there were warning signs of the negative effects that the consumption of sugar brings along, the consumption of sugar kept rising. This was also because sugar was not seen as a rare spice anymore, since it was discovered that sucrose can be derived from beets. Another reason was

that the damages of sugar were less acknowledged back then and sugar was seen as an essential commodity (Clay, 1999; , 2017).

Currently, there is a lot more knowledge about the harms of sugar and added sugar consumption. The consumption of an excessive amount of sugar can lead to many different forms of diseases and almost all of the literature agrees that an excessive amount of sugar consumption is bad for your health (WHO, 2022; WHO, 2021; Lustig et al., 2012).

2.3 Brief history of sugar consumption control

The first effective case of sugar consumption control can be found in Great Britain in the year 1764, when the Sugar Act was implemented. This act provided strong customs enforcement on the duties of sugar and molasses that were imported from foreign countries (countries that are non-British Caribbean) (Britannica, n.d.; Trethewey, 1969). However, the reason for this sugar taxation is a lot different than the reason for sugar taxation nowadays. The sugar taxation of the British descended from the need for money and that it was a luxury item and therefore scarce. There was a big need for liquidity since there was a highly expanded national debt that kept growing as a result of the Seven Years' war. This act existed for a little more than 100 years and was stopped in 1874 by Prime Minister Gladstone (Johnson, 1959).

The first form of sugar taxation for health reasons can be found in the Scandinavian countries in the form of Norway and Denmark. They implemented sugar tax in the 1920s and 1930s (Chaput et al., 2018). What is interesting here is that Denmark has decided to shelf this sugar taxation. There are multiple reasons behind this decision, but the two most important ones are that the sugar taxation is deemed ineffective and next to that it increases unemployment, so Denmark decided to stop its sugar taxation (Scott-Thomas, 2013). But while Denmark decided to stop its

sugar taxation, a lot of countries (or states) decided to implement a form of sugar taxation and in 2019 there were more than 40 instances of sugar taxation (Fernandez et al., 2019).

2.4 Taxation as a health policy

Sugar tax is not the only case of taxation in order to lower the consumption of an unhealthy product, which is also called simply called sin taxation. The two other prominent sin taxes in the world are tobacco tax and alcohol tax. The extra taxation on tobacco started in the seventies of last century but became much better in the eighties (Hiilamo et al. 2014). The reason that taxation here was chosen is that studies have found that 80% of the smokers start at the age of 18 (since that is the permitted age) and the people who try smoking at a later age are less likely to get addicted (Chaloupka, 1999). The lower the age the more harm smoking does. Therefore, is a policy that targets young people most preferrable and since young people are the most sensitive to price changes a policy form that plays into this would work the best and that is tobacco taxation in this case (Chaloupka et al., 1996). The other benefit of a tobacco tax here is that in the short term it mostly affects the young population, but since people at a later age are less likely to start smoking, it affects the whole population in the long run.

Taxation is also used to lower the consumption of alcohol. Alcohol consumption is, just like tobacco and sugar, seen as something very normal in our lives. However, harmful consumption of alcohol is approximately 10% of the total disease burden in the EU (WHO, 2005). The way that alcohol taxation often works is via MUP, which stands for minimum unit prices. The goal of having a MUP is that it increases the prices of the cheaper products. This lowers the consumption of alcohol in general, but it mostly used in order to lessen the amount of alcohol consumption by heavy consumers (Yeomans, 2017; de Wit et al., 2020).

This shows that although taxation is used to lower the amount of consumption of a harmful product in both cases that the thoughts behind the taxation do differ, since alcohol taxation is the only form of taxation that works with a MUP, while tobacco taxation is directly focused on the younger folks.

2.5 Rationale for Sugar Taxes

As also can be seen with alcohol and tobacco in the chapter before, there is a general idea that by taxing an unhealthy product that the consumption is lowered. The rationale behind this is that by modifying the price of a product you can alter its consumption (Fernandez et al., 2019; An, 2012). Next to changing the actual price of the product, a taxation also changes the price in comparison to healthier alternatives. An often used form of sugar taxation is a SSB tax and with this tax a healthier alternative like for example milk would be relatively less expensive than the soda drink (Buhler et al., 2013).

2.6 Effectiveness of Sugar taxation

Multiple studies have already shown that sugar taxation is an effective tool to lower diet related NCDs. Park et al. (2019) did this in a cross-country study where the effectiveness of SSB taxation, which is a form of sugar taxation, did lower the consumption of sugar sweetened beverages and found that this was effective. Nakhimovsky et al. (2016) found the same result in middle income countries and multiple other studies also argue that a sugar tax is effective (Tonks et al., 2013; Brownell et al., 2009; Finklestein et al., 2010)

However, there is also evidence that a sugar taxation does not lower obesity and the amount of sugar consumed. A rapport from the OECD (2015) shows that sugar taxation has negligible health impacts. This argument is supported by Sarlio-Lähteenkorva & Winkler (2015) and Snowdon (2013), which also state that taxation needs to be enormous in order to work. Next to that multiple countries had problems with their sugar tax and decided to repeal it, had it banned or withdrew their plans (Worldbank, 2020).

2.7 Price Elasticity of Demand

In order to understand the substantiality of the effect of sugar taxation on the intake of sugars, it is important to know what the price elasticity of sugary products is (Fernandez et al., 2019). With the basic theory behind this that an increase in price would lower the demand. While there is no direct price elasticity for sugar, since it is not only about sugar as a product, but it is also about added sugars and sugar rich products, some useful comments can be made about the elasticity of sugar rich products. An example of such a sugar rich product is SSB. Studies about the price elasticity of SSBs have been done in multiple countries. Colchero et al. (2015) did a study whereby they investigated the price elasticity of demand for SSBs in Mexico. Their research found that a 10% increase in the price led to a 11.6% decrease in the quantity consumed on average, this leads to a price elasticity of -1.16. A similar study was also done in Chile by Guerrero-López et al. (2017) and in Malaysia by Mohamed Nor et al. (2021). The study in Chile found a price-elasticity of -1.37 and the study in Malaysia found an elasticity of -1.11.

However, a study in the United Kingdom by Briggs (2013) estimates that the price elasticity for soft drinks is inelastic and that estimation is supported by the empirical evidence of an Oxford Economics (2016) study that shows that the sale of SSB has only fallen by 0.4% after the implementation of the sugar tax in the UK. A more recent study that was also done in Mexico found quite different results in comparison to the study done by Colchero et al. (2015). The study by Nava et al. (2022) finds that SSB is an inelastic good that has a price elasticity between -0.95 and -0.83. This again shows that there is no consensus whether a sugar tax would be an effective policy to lower sugar consumption.

2.8 Insights into sugar consumption

The previous paragraph shows that there is no direct answer to the question whether SSBs are an elastic or inelastic good. That multiple studies are able to show that SSBs are an elastic good is not in line with some of the other health literature. The consensus in health literature is that sugar/sucrose is an addictive substance (Benton, 2010; Avena, 2010; Serge et al., 2013). When a good is addictive, it should be inelastic. The reason for this is that when someone is addicted, they are less sensitive to price changes (Castiglione et al., 2015). Another study by Falbe et al., 2019 is also able to show that SSBs specific are an addictive good. They do not do that by looking at the price elasticity, but by looking at the withdrawal symptoms in case of SSBs cessation. That both sugar and SSBs specific are seen as addictive good should result in them being price inelastic, however the paragraph before shows that multiple studies have found that SSBs are price elastic and that does not match.

2.9 Other policies to reduce sugar intake

While most people can agree that an excessive amount of sugar intake is unhealthy and a problem that needs to be tackled, it does not mean that a sugar tax is the most efficient solution to do so and that it does not have negative effects on society. The most important argument here is the regressiveness of a sugar taxation. What is meant with that, is that the burden on people in the lowest income bracket is the highest. The reason behind this is that a sugar tax is regressive in two ways. First of all, it is regressive because all income taxes are regressive in nature and secondly because the poorest people spend more on product with added sugar (Snowdon, 2018). Because of this high burden on people with a low income it is also important to look at other policies that could reduce the sugar intake. The three best alternative policies to reduce sugar consumption are a regulation of food advertising, labelling, and teaching about the health effects and lastly by having

nutrition policies and school interventions (Köhler et al., 2016). The main benefit of these 3 other policies is that they are not regressive, however they all do have their other potential harms, for example the high costs that they bring along. Next to that it is important that the policies do not have to be substitutes but can also strengthen each other.

3 Methodology & data

3.1 Method

In order to test the first hypothesis that sugar taxation reduces sugar consumption, and the second hypothesis that sugar taxation reduces the consumption of sugar sweetened beverages, a combination of event study methodology and random effect methodology will be used. This will be further explained in this section.

An event study is a statistical methodology to assess the impact of an event, in this study the introduction of sugar taxation, on an outcome of interest, in this study sugar consumption or the consumption of sugar sweetened beverages. The event study methodology assumes that a reaction to a particular event leads to abnormal returns. Abnormal returns are the ex post returns over the event window minus the normal returns that are calculated over the estimation window.

When it is expected that all global information is taken into account in the dependent variable, the abnormal return per country shows how the event affects the dependent variable (Serra, 2004). However, in most event studies it is beneficial to look at the cumulative abnormal return (CAR) in a given period around the event date, which is called the event window. This is beneficial because it gives the opportunity to look at more than one abnormal return, since the impact of the event probably last longer than just one year.

Before the mathematical formula for the CAR can be given the formula for the abnormal return needs to be given as the formula for the CAR builds upon that formula.

The formula for the AR:

$$AR_{i,t} = R_{i,t} - (\alpha_i + \beta_i R_{m,t})$$

The formula for the CAR:

$$CAR_1(t_1, t_2) = \sum_{t=t_1}^{t_2} AR_{i,t}$$

t_1 and t_2 are the starting and ending date of the event window, which is the window in which the change in the dependent variable is measured compared to the refence market. $R_{i,t}$ is the return of the dependent variable, while $R_{m,t}$ is the return of the reference market. α and β are the parameters of this model.

Because the event study literature is more commonly used in financial literature the financial terms have been used to explain the event study. However, this study does not look at abnormal returns but at excess growth rates. So instead of the CAR the CAEGR is used which stands for cumulative average excess growth rates. This means that the returns are replaced with growth rates and that the reference market is in this case an index consisting of growth rates from other countries. This index ($GR_{m,t}$) is the average growth rate of all countries that did not implement a sugar tax in the period from 2004 till 2019. The mathematical formula looks like this:

$$GR_{m,t} = \frac{\sum GR}{nGR}$$

The numerator here is the sum of the growth rates of all countries that did not implement sugar taxation in the period from 2004 till 2019. While the denominator is the number of countries that did not implement sugar taxation during the period 2004 till 2019.

This all shows that a lot of the terms have changed, however the fundamentals of the formula stay the same. The formula for the CAEGR is:

$$CAEGR_1(t_1, t_2) = \sum_{t=t_1}^{t_2} EGR_{i,t}$$

And builds upon the formula for the excess growth rates:

$$EGR_{i,t} = GR_{i,t} - (\alpha_i + \beta_i GR_{m,t})$$

The reason event study methodology is more commonly used in financial literature has two major reasons. The first one is to test the null hypothesis that the market efficiently incorporates information (Binder, 1998; Fama, 1991). The second reason is to examine the impact of a specific event on the wealth of the firm's security holders, given that markets efficiently incorporate publicly available information. The financial literature uses it to examine security price behaviour around events, such as rule changes, earnings announcements, money announcements and multiple other event that can affect the security price behaviour (Binder, 1998). The popularity of this method can be well seen in the amount of citations that Fama et al. (1969) has. That paper firstly introduces the event study methodology and has racked up almost 8.000 citations.

This methodology of using an event study in order to measure the impact of sin taxation on the consumption of the product that is taxed on a global scale is something that is not often done[1]. And the literature shows that event study methodology is more commonly used in financial literature. However, it is also the best method to pursue in this paper. The reason for this is that many of the characteristics in this situation are in line with the characteristics of an event study. This paper studies how the implementation of sugar taxation impacts sugar and/or SSB consumption, assuming that this is an event that might lead to a change in a trend. Introducing a sugar taxation is more or less similar to an event in the financial market of in marketing strategies that leads to stocks giving an abnormal return (Warren et al., 2017). The expectation in this study is that implementing a sugar taxation lowers the sugar consumption over time but that the biggest difference is made shortly after the implementation period or even during the announcement period that such a sugar tax is implemented (Taylor et al., 2019). The study by Colchero et al. (2017) finds that the effect weakens after 2 years so that is the reason why this study uses an event window that looks up to 2 years after the event and since the event window is typically centred around the event year it starts at minus two years (Schimmer et al., 2014). However, when the event happened after 2017 the event window will be shorter, since data is only available till 2019. Next to that an estimation window is needed. There are two estimation windows used in this study. The first estimation window here is 15 years before the event window and the second estimation window is 4 years before the event window. The reason that two estimation windows are used here is because data on soda drinks consumption is only available from 2006 onwards and all tax implementation that are taken into account happen in or after 2012. So the event window will start in 2010 for the countries

[1] This study was not able to find any study that implemented an event study in this way.

which implemented their sugar taxation in 2012. And that means there are only 4 years left in the dataset to calculate the estimation window from.

The event studies in this paper are conducted with the *estudy* command in STATA and are based on the Single index model. Which is a simple asset pricing model that can measure the risk as well as the return of a stock. However, in this case it is about the consumption growth instead of a stock. The *estudy* command gives the labels of all countries that have sugar taxation in the left column and the cumulative average excess growth rate in the right column. The index is the average growth rate of the countries that did not implement sugar taxation in the years 2004 till 2019. This is used to compute the normal or excessive component in the consumption pattern that countries show (Pacicco et al., 2018).

The significance levels are based on the t statistic. MacKinlay (1997) argues that it can be assumed that the CAR is normally distributed and therefore parametric test can be used. The formula for the t test is as follows:

$$t = \frac{CAR_i}{S_{CAR}}$$

This applies:

$$S_{CAR}^2 = L_2 S_{AR_i}^2$$

S_{CAR} = the standard deviation of the CAR. This can be computed by the standard deviation of the abnormal return in combination with the event window, which is indicated by L_2. Since the CAEGR is fundamentally the same, the same formula can be used to calculate the significance levels of the CAEGR.

In addition to the events study, the random effects model is used here. A random effects model is chosen above a fixed effects model because some of the control variables are time invariant variables, which means that they are omitted. In order to give these control variables some meaning a random effects model needs to be used (Williams, 2018). These random effects will look at how much of the change in the dependent variable can be explained by the implementation of a sugar tax and how much is due to the control variables. To get more insight into the direct effect of the sugar tax on the dependent variable the period used here is the same as in the event study, however the measurements stop 2 years after the implementation of the sugar tax. This is so that if the effect declines over time this is not measured into the regression and thus shows only the effect of the implementation.

The third hypothesis of this study is that the form of taxation does matter for reducing the sugar consumption. For this analysis the countries with a sugar tax are compared based on what kind of sugar tax that they do have. However, since this research takes only 22 countries with a sugar tax into account this chapter will be both descriptive as well as empirical. This is done by dividing the results from the first 2 hypotheses into the two forms of sugar tax that are measurable, ad valorem excise tax and specific excise tax. Ad valorem excise taxes are taxes that are charged as a percentage of the value of the product. And specific excise taxes are taxes that are charged per quantity. Due to this difference the specific excise taxes are better predictable, and it is easier to determine the amount of tax, while ad valorem excise taxes do automatically adjust for inflation (Framework convention alliance, 2012). These two forms will be compared. On the one hand by comparing the results of countries that implemented the ad valorum excise tax form with the results of countries that implemented the specific excise tax. On the other hand, the two forms will be compared on the basis of what the current literature says about the tax forms. However, strictly

speaking, it is difficult to test this hypothesis given that the number of observations is too small to test this hypothesis statistically. Therefore, results with regard to this hypothesis will be tentative at the most.

3.2 Data

The dataset that will be used here consists out of 22 countries and the reference growth rate index. The 22 countries here are all countries which implemented a form of sugar taxation in the period of 2004 till 2019. Next to the 22 countries this study also uses a reference growth rate index. This is constructed out of all other countries (in total 139 countries) that have data on sugar consumption available and did not implement a sugar tax during the mentioned period.

For this period of 2004 till 2019 is chosen to make the study as relevant as possible for science as well as for policy. There were instances of sugar tax implementation before 2004, however those sugar taxes were implemented in the eighties of last century and therefore less relevant, since the world has changed a lot since then. Next to that were most of those countries (for example Samoa, French Polynesia and the Northern Mariana Islands) so small that no reliable data was available there (Worldbank, 2020).

Unfortunately, the number of data points is quite low, since there are very few countries that have implemented a sugar taxation and have sufficient data available. It would have been more ideal if more countries had implemented a sugar taxation and that there was also data available for the smaller countries. This all means that the interpretation of the results needs to be evaluated with caution.

3.3 Measurements

3.3.1 Dependent variables

The focus of this research is the change in the amount of sugar consumed. Data on the amount of sugar consumption for each country (in kilograms per capita) is extracted from the Helgi Library database. This data has been used to get the growth rate of sugar consumption, which is used as the dependent variable in this research.

For the second hypothesis, SSB consumption growth is used as the dependent variable. The reason that this data is used, is because almost all forms of sugar taxes are on the SSB and therefore have the highest effect on the sugar sweetened beverages consumption. Therefore, it would be interesting to see next to the effect on sugar consumption what the effect is on sugar sweetened beverages, in order to make a good comparison. The data for this is coming from Mendeley Data in the form of soft drink consumption in liters per capita.

3.3.2 Independent variables

The first independent variable is whether countries had a sugar tax or not in each year in the period 2004-2019. This is a dummy variable which has a value of 1 in the years that a country has a sugar tax and a value of 0 in the years that the country does not have a sugar tax. The expectation here is that sugar taxation does have a negative effect on the consumption of both soda as well as sugar. The data for this is provided by the World Health Organisation, World Bank and Cancer Council Victoria, which is a joint collaboration to provide the platform for future policy development in Australia.

The second independent variable is what form of sugar taxation a country has. This variable shows whether a country has an ad valorem or specific excise tax. While there are more forms of sugar taxation, like a value added tax or an import tariff, they cannot be taken into the comparison since

too little countries use those forms of sugar taxation. The data here is also provided by the World Health Organisation, World Bank and Cancer Council Victoria.

3.3.3 Control variables

Sugar taxation is not the only variable that does influences the consumption of sugar. The level of income also has an effect on sugar consumption, which is expected to be negative. So a higher level of income leads to lower sugar consumption (Masood et al., 2012). While income inequality would also be expected to have an effect on sugar consumption, multiple studies have found contradicting results here. The reason for this is that lower incomes obtain less sugar from healthy foods and more sugar from unhealthy foods, and for higher incomes this is the other way around (Masood et al., 2012; Berger et al., 2020). However, since multiple studies have analyzed the relationship between income inequality and sugar consumption, this paper does decide to take it into account as a control variable, even though it is not quite clear in which direction this effect is expected. The data on income inequality is retrieved in the form of the adjusted net national income per capita (in US dollars) and the Gini coefficients which are both extracted from the World Bank. Another control variable that is used in this research is the health sector. As already shown, an excessive sugar intake does have a negative effect on a person's health. Therefore, it would be important to control for the quality of the health sector in a country, because if the health sector has good quality people would be more likely to neglect the negative effect of sugar. To measure the quality of the health sector this study looks at the current health expenditure as a percentage of the GDP and the data is retrieved from the World Bank. The following control variable is education. The amount of knowledge about the dangers of too much sugar consumption does lower the amount of sugar consumed per person (Kolodinsky et al., 2007). And data from another study in Portugal by Prada et al. (2020) shows that education is related to

the amount of dietary knowledge. Therefore, it is important to look at the level of education in a country. This study measures education in the form of primary school enrollment (in a percentage of the total age group that officially corresponds to the level of education) and the data is also retrieved from the World Bank.

The following control variable is unemployment, as unemployment influences sugar consumption. Smed et al. (2017) show that there is a significant positive relation between unemployment and sugar consumption. The data for this is coming from the OECD and is measured in the percentage of the total labour force that is unemployed.

The last control variable are time dummies. Theses variables equal for the given year and 0 for all other years and are meant to control for time specific events that cannot be controlled by the other explanatory variables (Cizkowicz, 2015).

This all leads to the following regression equations. The first one is the equation for the random effects model for hypothesis 1, the equation here is:

Hypothesis 1 random effects

$$SUGARCONSUMPTIONGROWTH_{it} = \mu + \beta_1 SUGARTAX_{it} + \beta_2 HEALTHEXPENDITURE_{it} + \beta_3 EDUCATION_{it} + \beta_4 GINI_{it} + \beta_5 LOGINCOME_{it} + \sum_{t=1}^{T-1} t_t T_t + \alpha_i + e_{it}$$

$T_t = Time\ dummy$

$t_t = coefficient\ on\ time\ dummy\ T_t$

$\beta = the\ coefficient\ of\ the\ variable$

$\alpha_i = the\ random\ effects$

$e_{it} = the\ error\ term$

Hypothesis 1 event study

$$CUMULATIVE\ AVERAGE\ EXCESSIVE\ GROWTH\ RATE\ OF\ SUGAR\ CONSUMPTION\ \left(CAEGR(-2,2)\right)$$

$$= \sum_{t=-2}^{2} (GR_{i,t} - (\alpha_i + \beta_i GR_{m,t}))$$

$GR_{i,t} = the\ growth\ rate\ of\ the\ sugar\ consumption$

$GR_{m,t} = the\ growth\ rate\ of\ the\ index$

$\alpha_i, \beta_i = the\ parameters\ of\ this\ model$

Hypothesis 2 random effects

$$SODACONSUMPTIONGROWTH_{it} = \mu + \beta_1 SUGARTAX_{it} + \beta_2 HEALTHEXPENDITURE_{it} +$$

$$\beta_3 EDUCATION_{it} + \beta_4 GINI_{it} + \beta_5 LOGINCOME_{it} + \sum_{t=1}^{T-1} t_t T_t + U_i + W_{it}$$

$T_t = Time\ dummy$

$t_t = coefficient\ on\ time\ dummy\ T_t$

$\beta = the\ coefficient\ of\ the\ variable$

$\alpha_i = the\ random\ effects$

$e_{it} = the\ error\ term$

Hypothesis 2 event study

$$CUMULATIVE\ AVERAGE\ EXCESSIVE\ GROWTH\ RATE\ OF\ SODA\ CONSUMPTION\ \left(CAEGR(-2,2)\right)$$

$$= \sum_{t=-2}^{2} (\ GR_{i,t} - (\alpha_i + \beta_i GR_{m,t}))$$

$GR_{i,t} = the\ growth\ rate\ of\ the\ soda\ drinks\ consumption$

$GR_{m,t} = the\ growth\ rate\ of\ the\ index$

$\alpha_i, \beta_i = the\ parameters\ of\ this\ model$

Hypothesis 3 random effects:

$$SODACONSUMPTIONGROWTH_{ij} = \mu + \beta_1 AD\ VALOREM\ TAX_{it} + \beta_2 SPECIFIC\ EXCISE\ TAX_{it} +$$

$$\beta_3 HEALTHEXPENDITURE_{it} + \beta_4 EDUCATION_{it} + \beta_5 GINI_{it} + \beta_6 LOGINCOME_{it} + \sum_{t=1}^{T-1} t_t T_t +$$

$$U_i + W_{it}$$

$T_t = Time\ dummy$

$t_t = coefficient\ on\ time\ dummy\ T_t$

$\beta = the\ coefficient\ of\ the\ variable$

$\alpha_i = the\ random\ effects$

$e_{it} = the\ error\ term$

3.4 Overview of variables

In table 1 an overview of the variables used in the regressions is provided. In this summary the number of observations, the mean, the standard deviations, and the maximum and minimum values will be given for all included variables.

Table 1. Overview of variables

Descriptive Statistics

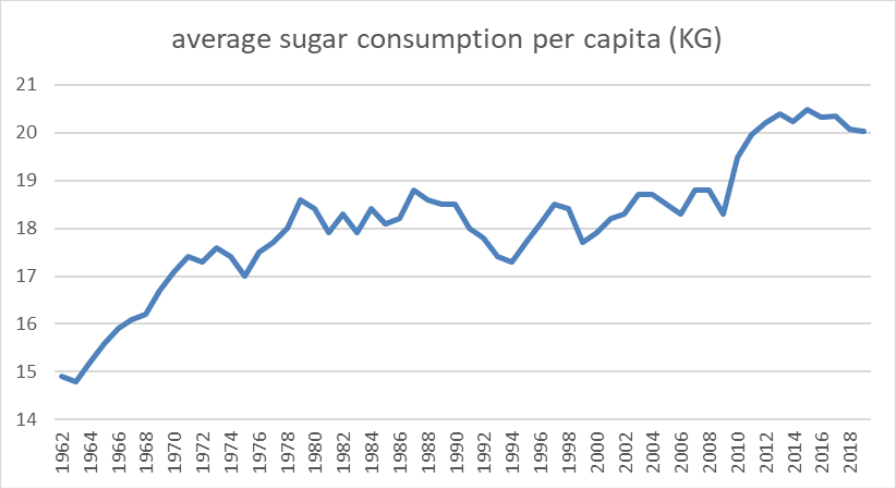
Variable	Obs	Mean	Std. Dev.	Min	Max
lnsugargrowth	2337	.005	.07	-.53	1.85
lnsodagrowth	1314	.019	.052	-.231	.303
sugartax	2577	.037	.188	0	1
healthexpenditure	2385	6.275	2.548	1.709	20.413
education	2065	103.655	12.987	42.139	149.957
gini	1147	36.976	8.056	23.2	64.8
logincome	2445	3.569	.654	1.813	5.182

4 Results

4.1 Positive trend in data

Figure 1 shows the average sugar consumption per capita of the world, which includes all countries with and without a sugar tax. While the line is of course not completely linear and the graph shows peaks and throughs, it still shows quite clearly a positive trend over the years with a rise in consumption of over 5kg per capita. To control for this trend an event study is used.

Figure 1. average sugar consumption per capita



4.2 Effect of sugar taxation

Table 2 shows the results for the changes in the growth rate of sugar consumption. The CAEGR stands for the cumulative average excessive growth rate and looks at how much the results for the countries with a change in sugar taxation differ from the index of the growth rates of the countries that introduced a sugar taxation in the period 2004-2019. The estimation window here is taken from 15 years before the event date and looks whether the implementation of a sugar tax has made a significant change in the period between two years before the event and two years after that. When the event date is after 2017, it does not measure for the two years after the event, but till 2019, since that is the last year that data is available. This study choses for the estimation period of 15 years since with this estimation period almost all countries from the data set that implemented sugar taxation can be taken into account, with the exception of Seychelles, since they do not have any data on sugar consumption from 2011 onwards.

The results here show two important aspects. The first one is that most countries show the expected negative effect and that they had a negative sugar consumption growth (16 countries show a negative effect, while 5 countries show a positive effect). However, and that is the most important aspect of this analysis, is that these results, both the ones with the positive effect as well as the ones

with a negative effect, do not show any significant results. Therefore, this table shows that there is no significant effect that the implementation of sugar taxation has on sugar consumption.

Table 2. Based on the growth rate of sugar consumption

Countries	CAEGR
Belgium	1.983%
Chile	-3.244%
Colombia	-8.436%
Ecuador	2.700%
Estonia	-38.495%
Fiji	-4.274%
France	-0.181%
Hungary	36.668%
India	-4.112%
Malaysia	-0.917%
Mauritius	-2.243%
Mexico	-5.788%
Peru	2.211%
Philippines	-9.789%
Portugal	-7.147%
Saudi Arabia	-29.617%
South Africa	-1.012%
Sri Lanka	20.469%
Thailand	-2.625%
UAE	-2.050%
UK	-8.712%

*** shows significance on a 99% confidence interval, ** shows significance on a 99% confidence interval, * shows significance on a 99% confidence interval

Table 3 shows the CAEGR for sugar consumption growth in the first column and the growth rate of soda consumption in the second column. Soda consumption here is used here as a dependent variable because all sugar taxes are applied on sugar sweetened beverages which form a large part of all soda drinks. The values for the CAEGR of the sugar consumption growth rate here do differ with the numbers of the previous graph. This differs because the previous analysis used an estimation window of 15 years, while the window here is only four years. The reason for that is that data on soda consumption growth is only available from 2006 onwards and therefore a period of 15 years cannot be used here to make the comparison. This shorter trend period also allows for all 22 countries with a sugar tax to be taken into account since the Seychelles only had data from 2010 onwards.

When looking at the content that is shown in table 3, it can be seen that there is now one significant results for the effect of sugar taxation on the amount of sugar consumption growth. This result for Hungary and is positive, which is unexpected.

The table shows that soda consumption has a lot more significant results and with the exception of the United Kingdom all these results are negative, as expected. The most logical reason for the difference here in comparison to the sugar consumption growth is that it has a more direct effect on soda drinks consumption and when the taxes are only applied on SSBs people can still get their amount of sugar from other non-extra taxed ways.

Table 3. Based on the growth rate soda consumption

Countries	CAEGR(growth sugar consumption)	CAEGR(growth soda consumption)
Belgium	3.902%	-4.726%**
Chile	-2.556%	-4.763%
Colombia	-7.200%	-15.415%***
Ecuador	3.050%	-41.693%***
Estonia	0.947%	13.304%
Fiji	-4.274%	-
France	1.214%	-6.761%
Hungary	48.450%*	-7.743%
India	-4.189%	-37.995%
Malaysia	-1.920%	-32.716%***
Mauritius	-2.013%	-
Mexico	-3.284%	-3.066%
Peru	0.656%	-12.413%
Philippines	-6.225%	-15.399%
Portugal	-3.860%	13.730%
Saudi Arabia	-23.797%	-48.813%
Seychelles	0.019%	-
South Africa	20.281%	-2.084%
Sri Lanka	-1.030%	-55.188%***
Thailand	-1.424%	-25.370%*
UAE	-9.299%	-8.518%
UK	3.902%	6.374%***

*** shows significance on a 99% confidence interval, ** shows significance on a 99% confidence interval, * shows significance on a 99% confidence interval

Table 4 shows the random effects model with the effects of sugar taxation on both on the growth in sugar consumption as well as on the growth in soda consumption. In total it looks at 124 countries when sugar consumption is the dependent variable and 79 countries when soda consumption is used as the dependent variable. This difference appears because there is less data available for soda consumption. The goal of the random effects model is to measure how much of the change in both sugar consumption growth as well as soda consumption growth can be explained by the independent variable, which is whether or not there is a sugar tax, and how much can be explained by the control variables. When the results of the two models are compared, it immediately shows that there are less significant results for sugar growth model in comparison to the soda growth

model. The sugar growth model shows a significant result for both income as well as for health expenditure. The other control variables in the form of education and the Gini coefficient show an effect that is almost zero and is not significant. When the significant results are compared to the results of the soda growth model it finds a similar effect for the logarithmic of income that is also significant, however for health expenditure it finds contradicting results, health expenditure does have a positive effect on the growth in sugar consumption while it does have a negative effect on the growth in soda consumption. Education does have a significant positive effect on the growth rate of soda consumption, what is surprising as knowledge should theoretically lower the soda consumption (Köhler et al., 2016).

The most important variable is the independent variable sugar taxation. The result here shows that sugar taxation increases the growth rate of sugar consumption. This is unexpected because the goal of a sin tax is to lower the consumption (Fernandez et al., 2019; An, 2012). However, this result is also not significant. While the result here is insignificant and positive, the result for soda consumption is different. The result here is significant and shows a negative effect with a coefficient of -0.017. This shows that sugar taxation does have a different effect on the growth rate of sugar consumption than the growth rate of soda consumption.

The model with soda consumption has much more explanatory power as the soda consumption model has a between R squared of 0.3431 (within $R^2 = 0.1931$, overall $R^2 = 0.2301$), while the sugar consumption model has a very low between R squared with a value of 0.0374 (within $R^2 = 0.0304$, overall $R^2 = 0.0360$). The coefficients here are unadjusted R-squares. This study looks at the between R squared value because this study wants to look at the difference between counties with sugar tax and countries without sugar tax.

This does make it interesting to look at the effect that sugar sweetened beverage consumption growth has on sugar consumption, since apparently according to the results of these test the changes in SSB consumption that are happening because of the implementation of a sugar taxation, which as said before is actually a SSB taxation, does not change the sugar consumption growth significantly.

Table 4 random effect models

VARIABLES	(1) lnsugargrowth	(2) lnsodagrowth
sugartax	0.011	-0.017**
	(0.013)	(0.009)
healthexpenditure	0.004*	-0.006***
	(0.002)	(0.002)
education	0.000	0.001**
	(0.000)	(0.000)
gini	0.000	0.000
	(0.001)	(0.000)
logincome	-0.020**	-0.014*
	(0.008)	(0.008)
yr_2	0.023*	
	(0.013)	
yr_3	-0.005	0.024**
	(0.013)	(0.010)
yr_4	-0.000	0.028***
	(0.013)	(0.010)
yr_5	0.004	0.012
	(0.013)	(0.010)
yr_6	-0.003	-0.034***
	(0.013)	(0.010)
yr_7	0.025**	0.005
	(0.013)	(0.010)
yr_8	0.007	-0.007
	(0.013)	(0.010)
yr_9	0.002	-0.001
	(0.013)	(0.010)
yr_10	0.002	0.000
	(0.013)	(0.010)
yr_11	0.004	-0.005
	(0.013)	(0.010)
yr_12	-0.003	-0.015
	(0.013)	(0.010)
yr_13	-0.008	-0.015
	(0.013)	(0.010)
yr_14	0.002	-0.016
	(0.013)	(0.010)
yr_15	0.002	-0.003
	(0.013)	(0.010)
o.yr_16	-	-
o.yr_2		-
Constant	0.022	0.023
	(0.050)	(0.046)
Observations	946	724
Number of countries	124	79

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5 shows the random effects model that looks at the effect that the growth rate of soda drinks consumption has on the growth rate of sugar consumption. This table shows that there is a significant and positive effect between soda consumption and sugar consumption. So, a growth in soda consumption leads to a growth in the consumption of sugar.

Table 5 Random effects model effect soda consumption growth rate

	(1)
VARIABLES	Sugar growth
Soda growth	0.043**
	(0.021)
healthexpenditure	-0.000
	(0.001)
education	-0.000
	(0.000)
gini	0.000
	(0.000)
logincome	0.001
	(0.003)
o.yr_2	-
yr_3	-0.013**
	(0.006)
yr_4	-0.005
	(0.006)
yr_5	-0.004
	(0.006)
yr_6	-0.006
	(0.006)
yr_7	0.021***
	(0.006)
yr_8	-0.000
	(0.006)
yr_9	-0.003
	(0.006)
yr_10	-0.000
	(0.006)
yr_11	-0.000
	(0.006)
yr_12	-0.007
	(0.006)
yr_13	-0.001
	(0.006)
yr_14	-0.002
	(0.006)
yr_15	-0.001
	(0.006)
o.yr_16	-
Constant	0.011
	(0.020)
Observations	724
Number of countries	79

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4.3 Effect of the taxation form

Table 3 has been split into both table 6, which shows the countries with an ad valorem excise tax, and table 7, which only shows the countries with a specific excise tax. This study choses to only look into the shorter trend period, because here the comparison with soda consumption is possible and that is the dependent variable that shows significant results.

As can be noticed some of the countries are missing that were in table 3. The reason for this is that some countries do not fit the description of an ad valorem or specific excise tax. The countries that do not match this description are Thailand, Colombia and India. Thailand namely does have both an ad valorem and a specific excise tax. India has a different system in the form of an increased rate of goods and services tax and Colombia uses another different approach by using a VAT system. What is interesting is that two of these three countries have a significant (negative) result. But they cannot really be considered as all three countries use a different system.

When the tax forms are compared, the first thing that immediately grabs the attention is the low amount of significant results and especially when looking at the ad valorem excise taxes. What should be expected here is that there is a significant negative effect of sugar tax on both sugar consumption as well as soda consumption. However, while all results here are indeed negative, there is only one significant result for soda consumption.

The table of the specific excise taxes shows a bit more significant results. Three countries of the eleven countries with data on soda consumption show a significant negative results here. So solely based on this, it seems that a specific excise tax is more effective than an ad valorem excise tax. However, what is quite surprising is that both instances of a positive significant effect can also be seen in specific excise tax countries. The first one is Hungary where the sugar tax does have a

significant positive effect on the amount of sugar consumed and the second is the United Kingdom where there is a positive significant effect on the amount of soda drinks consumed.

Next to comparing the individually reported event study results both forms of taxation can also be compared in a random effects model. Table 8 shows the random effects model that compares ad valorem and specific excise.

Table 6. Ad valorem excise tax

Countries	CAEGR (growth sugar consumption)	CAEGR (growth soda consumption)
Chile	-2.556%	-4.763%
Ecuador	3.050%	-41.693%***
Peru	0.656%	-12.413%
Saudi Arabia	-23.797%	-48.813%
UAE	-9.299%	-8.518%

*** shows significance on a 99% confidence interval, ** shows significance on a 99% confidence interval, * shows significance on a 99% confidence interval

Table 7. Specific excise tax

Countries	CAEGR (growth sugar consumption)	CAEGR (growth soda consumption)
Belgium	3.902%	-4.726%**
Estonia	0.947%	13.304%
Fiji	-4.274%	-
France	1.214%	-6.761%
Hungary	48.450%*	-7.743%
Malaysia	-1.920%	-32.716%***
Mauritius	-2.013%	-
Mexico	-3.284%	-3.066%
Philippines	-6.225%	-15.399%
Portugal	-3.860%	13.730%
Seychelles	0.019%	-
South Africa	20.281%	-2.084%
Sri Lanka	-1.030%	-55.188%***
UK	3.902%	6.374%***

*** shows significance on a 99% confidence interval, ** shows significance on a 99% confidence interval, * shows significance on a 99% confidence interval

Table 8 uses all the same variables as are used in table 4, but only looks at the effectiveness of the tax forms on soda consumption growth. The reason for this is that in table 4 shows that sugar taxation does not have a significant or negative effect on sugar consumption growth, therefore this model only looks at the effect on soda consumption. With a significant drop in observations compared to table 4, the coefficients and the significance of the control variables have also changed, only health expenditure still has a significant negative effect. The other control variables do not have significant results and show a very small coefficient.

The main part here are the dependent variables in the form of an ad valorem excise tax and a specific excise tax. Both tax forms show a negative effect here, which is expected. However, there are some differences. So is the coefficient for the ad valorem tax larger than the coefficient for the specific excise tax and more importantly the ad valorem excise tax shows a significant effect while the effect of the specific excise tax is insignificant. However, the sample set is low and therefore it is also important at the literature. Most studies here find that a specific excise tax is more effective in lowering the consumption because it is overshifted to the consumer prices while an ad valorem tax is undershifted to consumer prices (Bonnet et al., 2013; Framework convention alliance, 2012). What is interesting is that this is somewhat in line with the comparison from the individual results from the event studies since most significant negative effects there can be found at specific excise taxes, while the random effects study does not show a significant negative effect for the specific excise tax, but it does for the ad valorem excise tax.

However, this study simply does not have enough observations and therefor not enough power to make a reliable test. So, the indicators above only can be seen as indicators, but it would not be possible to draw any conclusions from that information. Therefore, this study is not able to say that one taxing method is more effective than the other taxing method.

Table 8. Random effects ad valorem and specific excise tax

VARIABLES	(1) lnsodagrowth
advalorem	-0.062***
	(0.021)
specific	-0.013
	(0.015)
healthexpenditure	-0.006*
	(0.003)
education	-0.000
	(0.001)
gini	0.001
	(0.001)
logincome	0.012
	(0.023)
o.yr_2	-
yr_3	0.023
	(0.033)
yr_4	0.032
	(0.033)
yr_5	0.009
	(0.033)
yr_6	-0.004
	(0.033)
yr_7	-0.008
	(0.033)
yr_8	-0.003
	(0.033)
yr_9	-0.021
	(0.032)
yr_10	-0.011
	(0.032)
yr_11	-0.020
	(0.033)
yr_12	-0.015
	(0.033)
yr_13	0.002
	(0.033)
yr_14	-0.031
	(0.032)
yr_15	-0.006
	(0.033)
Constant	0.012
	(0.143)
Observations	119
Number of c_id	14

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5 Conclusion and Discussion

The results of this research lead to three main conclusions. The first one is that sugar taxation does not influence the amount of sugar that is consumed. The second conclusion is that sugar taxation does have a significant effect on the consumption of soda drinks and the third and the last conclusion of this research is that it is not possible to draw firm conclusions with regard to the question which form of sugar taxation is more effective, given that the study sample did not have sufficient power for testing the hypothesis. At the same time existing literature with regard to the question of effective sugar taxation forms is contradictory. The main attempt of this study was to fill the gap in the current literature, which does not talk about the effects of sugar taxation on the amount of sugar consumption and thus whether sugar taxation would be an effective tool to reduce the sugar consumption. The current literature already did not agree whether sugar taxation would be effective in lowering the amount of SSB consumption. Park et al. (2019) found in their study that sugar taxation would be effective in lowering the SSB consumption, while Snowdon (2013) found contradicting results and argued that it would be ineffective. Both the event study and the random effect model in this study showed that for most countries sugar taxation led to a reduction of soda consumption. However, it did find that some countries did not show a significant effect and that for the United Kingdom there was even a positive significant effect. This can explain why some literature did not find an effect in their country specific studies (Sarlio-Lähteenkorva et al., 2015; Snowdon 2013).

5.1 Policy recommendations

These results open a path for future research into sugar taxation, since this research shows that the current form is not effective in changing the consumption of sugar. So, it would be interesting for

future research to look more into the height of the sugar taxes and whether a change there would be able to make them more effective. Next to that, it would also be interesting for both science and policy to look into other ways to implement sugar taxation, for example not by taxing SSB but by taxing on the basis of the amount of sugar products contain. This would be in line with the study by Köhler et al. (2016) which shows that there are other policies, such as regulation of food advertising & raising awareness about the health effects, that can lower the sugar intake and that do not only focus on SSBs. Also, other forms of taxation would be interesting to look into, for example by taxing on the amount of sugar that a product contains. By taxing in this way, it would not be able to substitute sugar consumption in SSB by simply buying another sugar rich product which is not taxed. These possible future studies might be able to show a way in which sugar taxation is able to lower the amount of sugar consumed.

Next to these two possibilities for future research, this study also offers another opportunity. The worldwide consumption of sugar shows a big decrease in the year 1986 till 1994 and such a drop would be beneficial nowadays. However, this study was not able to find any direct effects that might have led to this big decrease in sugar consumption, since it was not the focus of this study. So, in order to possibly recreate that decrease it would be interesting to look into the cause of it.

Lastly the random effects model (table 4) did not show any variable that influenced the amount of sugar consumed. So, to make policy design more effective, studying what variables would influence the consumption would be beneficial.

5.2 Research limitations

This research and its data do have some limitations. One of the first problems that this research faced was that there is little data available. While sugar taxation is implemented into almost 40 countries, only 22 of them could be taken into account in this research. The reason for this is that many of these countries are so small that they are not taken into account in the more common and reliable datasets. This makes it impossible to draw any conclusions from those countries. Next to this, the timespan of the data available is also a problem. Data on soda consumption was only available from 2006 onwards and for the study it would have been better if a larger timespan could have been covered as was the case for the sugar consumption. Next to the timespan, it would have been better if data on sugar sweetened beverages consumption directly was available instead of having to use soda consumption as a proxy, although those are closely related.

Another limitation of this study might be that part of the changes in sugar consumption might have been caused by policies or factors that were not taken into account. Sugar consumption policies such as advertisement bans or local sugar taxes, might have played a role, but could not be measures in the present study. This might have influenced the results of this study, but at the same time it has to be acknowledged that not all possible factors of influence can be included in one study.

The final limitation of this research is that it tries to look at the situation from a macroeconomic perspective and therefore it does not completely show the multidisciplinary nature of sugar taxation. It would be interesting to see a collaboration on this type of study with researchers that have knowledge of health and psychology. This research touches the surface of the negative effect that sugar consumption has on the health of society, but it would have been better if this topic could be deeper dived into, to show the relevance of reducing the sugar intake of society. Next to a health

point of view it would also be interesting to have some more insight into the psychological insights of addictive substances and how that does relate to sugar consumption.

5.3 Conclusion

The first hypothesis assumed that there would be a significant negative association between sugar taxation and the amount of sugar consumed. However, the results of this study did not show such an association. So, it can be understood from the results that this study gives that sugar taxation does not have an effect on the consumption of sugar.

The second hypothesis assumed that there would be a negative and significant association between sugar taxation and the amount of sugar sweetened beverages consumed. This hypothesis can be accepted by this research. Most countries in the event study show a significant negative effect of sugar taxation on the amount of soda drinks consumed. Next to that the random effect study also shows a significant negative result. Which is in line with most of the literature on sugar taxation that shows that taxation is able to lower the amount of sugar consumed (Tonks et al., 2013; Brownell et al., 2009; Finklestein et al., 2010). Next to that, previous research showed that sugar taxation is ineffective if one focuses on individual countries and this study also finds insignificant results in some cases, like for example Great Britain, where the literature also already shows that the sugar tax is ineffective (Briggs, 2013; Oxford Economics, 2016). However, in total all these results show that sugar taxation indeed leads to a significant decrease in the consumption of soda drinks.

The third hypothesis indicates that one form of sugar taxation should be more effective than the other forms of sugar taxation. This research is only able to look at two forms of taxation, ad valorem excise tax and specific excise tax, and this study finds contradicting results whether one form of

sugar taxation is more effective than the other. The random effects model (table 8) shows that ad valorem has a larger coefficient and that it has a significant result in comparison to specific excise tax. However, due to the very few countries that have data available it is not a strong conclusion, and the current literature disagrees as they argue that a specific excise tax is more effective (Bonnet et al., 2013; Framework convention alliance, 2012).

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