The Effects of Taxing Sugar Sweetened Beverages

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I. Introduction

Obesity is becoming an increasingly larger problem in the western world, in the United States around 20% of all healthcare expenditure is accounted for by obesity related diseases (WHO, 2003). These diseases include cancer, strokes, type 2 diabetes and heart disease. Two third of all Americans is considered overweight and one third is considered obese. The Economic costs of diet-related diseases have been estimated to be at least $71 billion annually (Jacobson, Brownell). The Surgeon General estimated the total cost of obesity in the United States around $117 billion dollars for 2001 whereas Brownell et al. (2009) estimate the cost of overweight and obesity at $147 billion in 2009, which is 9,1% of the healthcare expenditures in the United States. In the Netherlands 48,2% of the population was considered overweight in 2011, 11,4% of whom were considered obese with the Healthcare Expenditures at 14,9% of the GDP (CBS Statline).

Being overweight is the result of consuming more energy (calories) than one needs, to perform daily activities. As a result an individual will gain weight from overconsumption as the body stores the energy for later use. There are several theories that attempt to explain the trend that an increasingly larger part of the population is now overweight.

Technology has taken away most of the manual labour, making work a more sedentary activity (Lakdawalla and Phillipson, 2002). Between office jobs, television and the internet, people's lives are more sedentary than they were in the past, which results in lower demands for energy.

On the other side we can see that eating habits have changed over the years. This is a result from the changing nature of the food supply (French, 2003). Over the years there has been an increase in the consumption of 'foods away from home'. Because of this shifting dynamic the importance of marketing and food pricing in dietary choices has increased. Cheap food high in calories offer good value for money, while at the same time serving sizes have increased over the years (Young and Nestle, 1995).

While the daily amount of calories required has gone down slightly over the years, there has been a steady increase in the amount of calories consumed. This has resulted in the increase of average bodyweight and increasing prevalence of obesity (Cutler, 2003).

In 1994, Kelly Brownell was the first to suggest that governments impose a so called 'Soda Tax'. This can be a sales tax, excise tax or ad valorem tax to discourage people from purchasing sugar-beverages like soda, soft drinks or carbonated water.

According to Vartanian et al. (2007) the increase in soda consumption has mirrored the increase in obesity rates. A study in the United States has shown that 9% of the total energy intake comes from sweetened beverages (Block, 2004). Another study has shown that a greater consumption of sugar-sweetened beverages is associated with weight gain and obesity in both children and adults (Malik, Schulze and Hu, 2006).

The Netherlands is currently in the top five with regards to soft drink consumption in EU- countries. A possible solution for this problem for the Netherlands can be found in increased taxation of sugar-sweetened beverages like sodas and soft drinks, since the higher prices can reduce its consumption. Taxation can be an efficient way to reduce consumption since the Law of Demand dictates that higher prices lead to lower demand. Taxation is, compared to legislation, a very cost effective way to achieve policy goals and the additional tax revenues can help fund the Healthcare expenditures or can be used to subsidize more healthy food alternatives.

In the Netherlands there is a low Value Added Tax on sodas and soft drinks since they are considered food products and a basic human necessity. We are interested in an increased tax on these beverages, either through an increase of the VAT to the high rate of 21% (for luxury goods) or through an excise tax per litre. To examine the possibilities of a tax increase we will have to look at the effects of such a policy, so in this paper we will research the following:

"What is the economic impact of a tax on sugar- and artificially sweetened beverages in the Netherlands?"

In this paper we will focus on three effects that we deem to be most prevalent. We will look at the increased tax revenues, we will look at price effects and we will look at the tax effects on the consumption of sugar-sweetened beverages.

Lastly, we will study the effects of a tax on reduced consumption and estimate the effects of such a tax on the prevalence of overweight and its effect on the cost of healthcare.

II. Theoretical Framework

In this Theoretical Framework we further explicate the views as put forth in this paper. We start by theorizing the effects of taxing sugar-sweetened beverages on bodyweight, soft drink prices and consumption. We will discuss the hypotheses we formulated and we will define the concepts involved.

Furthermore we will provide a theoretical background for taxation as a policy measure, current tax policies, price elasticity effects, the effects of price shifting and the effect of substitution. Lastly we will discuss the decisions on what to tax and the effects of reducing overweight on the healthcare expenditures.

The effects of taxing sugar-sweetened beverages on bodyweight, soda price and consumption; six hypotheses.

When using taxation as a policy measure to battle obesity we will have to estimate its effectiveness through the effect of reduced consumption. We will look at the relation between tax and consumption, between consumption and overweight prevalence, and lastly the direct relation between tax and overweight. To see if a reduction in overweight will lead to lower healthcare expenditures we will also look at the relation between overweight prevalence and healthcare expenditures over time. We have formed six hypotheses to help answer our research question.

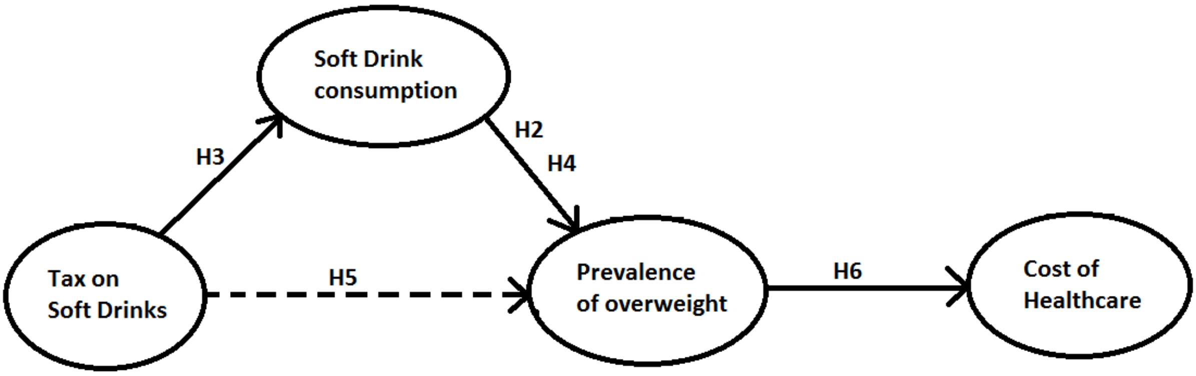
The first hypothesis is a theoretical research into the relation between sugar-sweetened beverages and obesity because this link will be a stepping stone in establishing a relation between tax increase and overweight reduction.

Hypotheses 2 and 4 support a model which we will use to estimate the effect of consuming sugar-sweetened beverages on the prevalence of overweight.

Hypotheses 3 and 5 are the next step where we will try to establish the direct effect of taxation on consumption and the prevalence of overweight.

The last hypothesis tries to estimate what the effect of overweight is on the healthcare expenditures.

This is theoretical framework graphically with hypotheses 2 through 6:



Hypothesis 1:

"Soft drinks are a large contributor to increased energy intake over the past few years"

Hypothesis 2:

"The increase in Soda consumption is correlated with the increase in overweight"

Hypothesis 3:

"An increase of tax will reduce the consumption of sugar-sweetened beverages"

Hypothesis 4:

"A decrease in consumption will reduce overweight"

Hypothesis 5:

"An increase of the tax will reduce overweight"

Hypothesis 6:

"Lowering the prevalence of overweight will reduce the cost of healthcare"

To study if tax can be used as a policy measure to reduce consumption we will review various pieces of literature on the subject. Having argued the reasons for a tax on sugar-sweetened beverages we will now explain the related effects of such a tax, to substantiate the claims.

Concepts

In this chapter we will explain the concepts that we use in our analysis, and we will explain the definitions for the different types of beverages and taxes that we will use in this paper.

Sugar-sweetened beverages is a broad definition to include all non alcoholic beverages like sodas and soft drinks, fruit-juice concentrates and carbonated water containing naturally derived caloric sweeteners such as sucrose, high fructose corn syrup. Unless mentioned specifically, any reference to sugar sweetened beverages, soft drinks or sodas all refer to the entire group of beverages, excluding non-caloric (diet) soft drinks.

Artificially sweetened beverages defines the non alcoholic beverages containing artificially derived non-caloric sweeteners such as aspartame, sucralose and acesulfame K. These are the 'diet' and 'light' soft drinks.

As a result of reviewing literature from different years and countries there is inconsistency in the phrasing of the tax. We use the same phrasing as the authors of this literature so whenever there is a mention of soft drink tax, Soda Tax or Beverage Tax, the same tax is referred to.

Value Added Tax (B.T.W in Dutch) is an AD Valorem Tax on goods or services sold, and this tax is paid by the consumer. In the Netherlands there is a low-rate and a high-rate. The low-rate is 6% and is applied to all basic human necessities e.g. food. Other products e.g. non-food and luxury items are taxed at a 21% rate.

An Excise Tax is a fixed amount of tax which is applied over a quantity; this ensures that all drinks are taxed equally e.g. 6 cents per litre, rather than a percentage change which affects budget brands and A brands differently. This excise tax is imposed on the producers of the products who can then pass in through onto retailers and consumers. On top of an excise tax an ad valorem tax can exist. This is a tax imposed on goods sold, and are ultimately paid for by the consumers.

BMI is the Body Mass index, an index used to make general assumptions about body composition. It is derived from the formula: $BMI = \frac{Weight\ (kg)}{Length\ (m)^2}$

We consider a person to be overweight at BMI >25. And when referring to the prevalence of overweight we refer to the percentage of the population that is overweight. This is done by using a binary variable for overweight which looks like this.

$$Overweight = \begin{cases} 1\ if\ BMI_i \geq 25 \\ 0\ if\ BMI_i < 25 \end{cases}$$

Changes in bodyweight are noted in the same measure of unit as the original article which sometimes uses the imperial system and other times uses the metric system. When we refer to pounds of bodyweight we refer to the avoirdupois pound, which equals 0,454 kg.

A tax on sugar-sweetened beverages as a policy measure

Why do we put such an emphasis on sugar-sweetened beverages instead of unhealthy foods? In this chapter we will discuss the arguments for inducing a tax. Both from a public health, as well as a policy point of view with regards to illnesses and market failures.

In the first place it is easier in legal terms to administer tax on certain food types rather than macronutrient values like (trans-)fat, secondly these beverages offer no nutritional value while most dairy and milk (often containing fat) do offer nutritional value generally associated with a healthy diet. Lastly, the consumption of sugar-sweetened beverages has been directly linked to obesity and diabetes (Brownell, 2012) and indirectly through obesity which had been linked to coronary heart disease, strokes, cancer and type 2 diabetes (WHO, 2003) .

Studies have shown that people consuming sugar-sweetened beverages like soft drinks had a total daily calorie intake that is 17% higher than their typical diet would suggest, even after taking into account the energy from soft drinks. The total energy intake was greater than what could be explained by the soft drinks alone, which suggests that the High Glycemic nature of these drinks stimulate appetite (Vartanian et al., 2007), which is results in a greater overall energy intake.

Furthermore there are similar trends between soft drink consumption and obesity. From 1970 until 1997 soft drink consumption went up by 86% while obesity increased by 112% (Vartanian et al., 2007). Although these are broad correlations studies have shown that there is a distinct, significant association between increased soft drink consumption and energy intake, where the total energy intake exceeds the energy from soft drinks alone.

So why would people choose to consume soft drinks which they know offer no nutritional value and can lead to, amongst other things, diabetes. To see why this happens and why taxation can be the answer we have to look at why people make certain dietary decisions.

When it comes to food choices, there are three dimensions. Taste, perceived value and perceived nutrition. Perceived value relates to portion size and price, while perceived nutrition includes nutritional properties like calories and vitamins. Food choices vary along each of these three dimension (Glanz et al., 1998). Even people who were equipped with the proper dietary knowledge may still prefer cheaper, tastier food and place less importance on its nutritional quality. People with a lower socio-economic status more often lean towards the perceived value dimension (French, 2003). An increase in price of these foods, like sugar-sweetened beverages, can reduce its attractiveness by reducing the perceived value.

An eight year cohort study among 91,249 women showed that the women who consumed one or more serving of sugar-sweetened beverages daily had almost double the risk of diabetes compared to the women consuming less than one serving per month. Half of the increased risk was attributed to the greater body weight. The women consuming one or more per day also suffered a 23% increased risk of coronary heart disease. Another study compared women either increasing or decreasing their intake of sugar-sweetened beverages. The study showed a gain of 8kg in bodyweight for the women increasing their intake, whereas the women decreasing their intake gained 2,8kg of bodyweight (Brownell et al., 2009).

Different studies with regard to diet and sugar-sweetened beverages have all shown that consumption of beverages does not change eating behaviour with regard to solid foods. The consumption of solid foods is usually related to satiating hunger while consumption of beverages is mostly to satisfy thirst, or for social reasons (Brownell et al., 2009).

The final reason for policy makers to levy a tax is the existence of market failures. In the 'market' of beverage consumption we deal with three aspects of market failure. The main aspect is the presence of externalities. Consumers currently pay very little tax on sugar-sweetened beverages and if the costs of healthcare as a consequence of this consumption are increasing this will result in the market price not accounting for the true social costs associated with the products. Consumers do not bear the external costs and consequently consume too much[1]. This situation already exists for alcohol and tobacco so similarly, if a relationship between consumption of sugar-sweetened beverages and healthcare expenditures is established, they should be taxed. The second aspect is imperfect information. Consumers are often not familiar with dietary or nutritional concepts and as a result cannot make well informed decisions. The last aspect is that of time-inconsistent preferences, consumers have problems discounting future utility and consequently favour utility in the present, rather than the future. This results in overconsumption in the present, which causes disutility later in life.

Current tax policies

In 1972 a small excise duty tax on non-alcoholic beverages was implemented in the Netherlands, this excise duty was introduced with the purpose of raising tax revenues to deal with the budget deficit. When the European Union's Internal Market came about in 1993 it was no longer allowed for member states of the European Union to levy excise duties on products other than alcohol, tobacco and petrol. The Dutch government as a result, changed the tax from an excise duty to an excise tax. This allowed them to continue to levy the tax without breaking EU regulation.

The excise tax rates for soft drinks and sodas is currently 5,5 cents per litre, and the excise tax rate for mineral water and fruit juice is 4,13 cents per litre. On top of this an ad valorem tax of 6% is induced on all goods sold.

In order to properly assess the effect of the tax on the price and consumption of sugar-sweetened beverages several effects are important. Firstly the direct effect of price elasticity of demand, secondly the indirect effect of complements and substitutes, and thirdly we will consider the pass-through effects that should also be taken into account.

[1] From a social point of view, where social costs exceed aggregate private benefits.

The effects of price elasticity of demand

In this chapter we will look at price elasticity of demand, which shows the relation between changes in demand as a result of changes in price level. We will also explain energy accounting and look at several studies on the effect of a tax on overweight or weight loss.

A study by Smith, Lin and Lee (2010) suggests that a tax-induced price increase of 20% could lead to a consumption reduction of 37 calories per day for adults and 43 calories per day for children. This amounts to a total of 3,8 pounds for adults and 4,5 pounds for children annually using the principle of Energy Accounting.

Energy Accounting is a method used to calculate bodyweight in terms of energy consumed and energy spent. If a person's consumption exceeds his energy expenditures he will gain weight, whereas weight loss will occur when energy expenditures exceed consumption. Empirical studies have shown that 3500 calories equal 1 pound of bodyweight (Whitney et al., 2002), so an overconsumption of 125 calories per day will result in a weight gain of 1 pound per month. Energy accounting is invaluable when estimating individual energy demand or expected weight based on activity levels and consumption and is mathematically illustrated by the equations on the next page.

$$K = \sum_{a=1}^{A} W(MET_a)(time_a)$$

$$W = \frac{K}{\sum_{a=1}^{A}(MET_a)(time_a)}$$

Where *K* is the total amount of calories consumed, *W* is bodyweight and $(MET_a)(time_a)$ is the work metabolic rate of an activity *a*, multiplied by the time spent on that activity (Schroeter, Lusk and Tyner, 2007). The intuition behind these equations is that an active person will burn more calories and as a result requires more calories, and also that in an equilibrium situation a reduction in calories will result in a weight loss.

With this in mind we have to remark that while the relation shown by Smith, Lin and Lee (2010) has empirical merit it does not mean that a reduction of caloric intake reduces bodyweight on an individual level. If a person consumes less calories but still in excess of his daily energy requirement that person will still gain weight. The adult in this example will have been 3,8 pounds less heavy than he otherwise would have been rather than reducing his bodyweight by this amount. They base their predictions on the assumption that 90% of the population only slightly over consumes, so even minor reductions of 100 calories per day will prevent weight gain (Hill et al., 2003).

The prediction the authors make is that overweight prevalence in adults could decline from 66,9 to 62,4 percent point, a reduction of 7,2%. For children the effect could be even larger at an estimated reduction of 21.17%. From 16,6 to 13,7 percent point. These estimations are based on the premise that most adults and children are only overweight by a few pounds, and only slightly over consume. A small adjustment would put them into a state of (minimal) weight loss and out of the overweight statistic. Furthermore they argue that people who are overweight consume a lot of sugar-sweetened beverages, causing them to be strongly affected by the tax-induced price increase.

According to Tefft (2008), a tax induced increase of soft drinks prices does not reduce household expenditures on soft drinks, and the increase reduces the probability of any expenses on soft drinks. Since an increase in tax should lead to increased aggregate expenditures at the same levels of consumption this results into taxes reducing soft drink consumption.

Fletcher, Frisvold and Tefft (2010) made a model for the United States to see if soft drink tax can reduce population weight. They looked at states with different tax rates and used a two-way fixed-effect Ordinary Least Squares framework to estimate the effect. Their model is specified as follows:

$$outcome_{istq} = \beta'_1 X_{istq} + \beta_2 T_{stq} + \mu_s + \delta_t + \gamma_q + \varepsilon_{istq}$$

This model estimates the outcome of individuals *i* in state *s* at time *t* in quarter *q*. X is a vector if individual-level covariates like gender or race and T is the state level tax. μ represents state fixed effects, δ represents year fixed effects and γ represents quarter fixed effects.

What they found was a statistically significant effect of taxation on population weight, although the effect was small. A 1% increase in soft drink tax results in a reduction of overall BMI by 0,003, a reduction in overweight by 0,02 and a reduction in obesity by 0,01 percentage points (Fletcher, Frisvold and Tefft, 2010).

What Schroeter, Lusk and Tyner (2007) found in their study is that excise taxes on soft drinks have a small, yet significant effect on the change of bodyweight in individuals. A 10% tax on caloric soft drinks will lead to an estimated weight loss of 0,099% and 0,122% for males and females respectively. This is consistent with the findings of Jacobson and Brownell (2000), and Fletcher, Frisvold and Tefft (2010).

Zheng and Kaiser (2008) have constructed a system-wide framework to look at price elasticities between five types of non-alcoholic beverages. The beverage types considered were milk, juice, soft drinks, bottled water and coffee/tea. They have found that a price increase of soft drinks by 1% reduces its own demand by 0,151%, which results in an own-price elasticity of -0,151.

Andreyeva, Long and Brownell (2010) reviewed studies on the price elasticity of demand for food and non-alcoholic beverages between 1938 and 2007. They have estimated a mean price elasticity for different food categories and they have estimated the ‘absolute value of mean price elasticity’ for soft drinks to be a relatively elastic -0,79, noting that a 10% increase in price will likely reduce the consumption of soft drinks by 8-10%. This is quite similar to the results from the study by Duffey et al. (2010) where a 20 year long cohort study concluded that a soft drink price increase of 10% results in a reduction of energy intake from soft drinks by 7,12%, which amounts to an effect of -0,712.

All these studies have looked into the price effect on the consumption of food in relation to itself and other food or drinks. None of them looked into any differences between price elasticities for low income consumers, and aggregate price elasticities for consumers as a whole. Intuitively one would expect lower income consumers to have a higher elasticity than the aggregate consumer elasticity. Several studies on this subject however, have concluded that there is no difference in food price elasticity between income groups (Andreyeva, Long and Brownell, 2010).

The effects of price shifting

In this chapter we will explain what price shifting is and how it relates to the effect of inducing a tax on certain products. We will look at the differences between excise and ad valorem taxes and we will look at the pricing effects of the soda tax that was implemented in France.

Price shifting is the manner in which the tax-induced price increase results in the final price of a product. Under the standard competitive model we assume that the after-tax price is increased by exactly the amount of the tax but imperfect competition can lead to over-shifting or under-shifting effects.

It is possible for retailers to keep the consumer price down at their own expense. The incidence of taxation then falls on the firms rather than consumers and to compensate this loss of margin firms can increase the price of other products, this is called under-shifting. In Denmark the Fat-Tax caused an under-shifting effect where large retailers like supermarkets did not pass through the full tax on products like meat and butter, while increasing the price of non-taxed products (Jensen and Smed, 2012). This way they managed to spread the tax across a large variety of goods reducing the impact of the fat tax on goods sold at supermarkets. At the same time it caused an additional effect where consumers would purchase the taxed goods in supermarkets rather than small businesses like butcher shops, causing financial problems for them.

The other option is to make taxed products even more expensive, the over-shifting effect. Besley and Rosen (1999) found that an increase in soft drink tax will result in an even stronger increase in the price of soft drinks. The change in price exceeds the tax change by 29%. This over-shifting of the tax burden is the result of imperfect competition in the soft drink industry. While the over-shifting effect contrasts the theoretical models with upward sloping supply curves, the empirical data finds that the retail market is indeed imperfectly competitive (Anderson, 1990).

The pass-through effect and tax incidence have also been studied by Bonnet and Réquillart (2011) and they concluded that there is a difference between excise tax and ad valorem tax. When price elasticity of demand is relatively price-inelastic (smaller than one), an excise tax is over-shifted, while an ad valorem tax is more likely to be under-shifted. The practice of completely passing through the tax with shifting is referred to as 'passive pricing'. Passive because it is absent pricing strategies. Since the market for soft drinks is dominated by two large alliances, Coca Cola Enterprises/Cadbury Schweppes and Unilever/Pepsiso, it is characterized as a duopoly with two large players having market power. This imperfection results in taxes not being perfectly passed on to consumers (Bonnet and Réquillart, 2011).

The ad valorem study shows that firms pass on 60% to 90% of the total tax increase on to the consumers, while the excise tax study shows that 107% to 133% of the total tax increase is passed on to the consumers. This is consistent with the results found by Besley and Rosen.

These findings suggest that an excise tax is more efficient when the policy goal is reducing consumption because through pricing strategies the tax effect is amplified. Furthermore they found own price elasticities for sweetened beverages in France to be similar to the ones Schroeter, Lusk and Tyner (2007) found for the United States, we will discuss their findings in the next chapter.

The impact of a soda tax on obesity and health has mostly been estimated under the assumption of a full pass-through of the tax to prices, without any over-shifting or under-shifting effects. Ignoring pricing strategies can lead to misestimating the impact of taxation by 15%-40%, depending on the type of beverage and brand Bonnet and Réquillart (2011).

A study examining the short term outcomes of the French Soda Tax, introduced in 2012, showed that there was a fully shifted tax to price for soft drinks for which there are no close untaxed substitutes. For the other beverages e.g. flavoured water or fruit drinks there was a light under-shifting, prices went up by an average of 6 cents per litre while the tax is set at 7,16 cents per litre. The existence of untaxed substitutes may be partial to this under-shifting. Across retailers and brands there was a strong heterogeneity where some over-shifted the tax while others under-shifted, a commonly observed pricing policy is the over-shifting of tax onto the retailers' private label products (Berardi et al., 2012).

One possible explanation provided is that lower prices on private label products allow retailers less flexibility to absorb the tax. Another explanation is that national brands with large market shares can introduce or promote collaboration between producers and retailers.

The effects of substitution

In this chapter we will consider the indirect effects of complements and substitutes. For this we will review an economic model of the impact of food pricing and income changes on bodyweight by Schroeter, Lusk and Tyner (2007).

This model attempts to show a relation between food prices and income on bodyweight, with the inclusion of substitution effects. The Law of Demand states that demand decreases as price increases, but when there are substitution effects this will not necessarily result in weight loss. The closer the substitutes are to the taxed products, the higher is the price elasticity. Because it is hard to get good data on this subject the model uses price-, income-, and weight elasticity with a cross-elasticity table from Dhar et al. (2003).

Schroeter, Lusk and Tyner (2007) found that with strong substitutes a tax was less effective, and while the tax did reduce soft drink consumption it did not affect bodyweight drastically. Expected substitutes for regular soft drinks are the diet versions of these drinks, but they found that fruit juice and milk were also used as close substitutes for soft drinks, which resulted in soft drink consumption going down while calorie intake remained constant. Seeing how it would not necessarily be unhealthy to switch from soft drinks to milk and juice this, in the long run, could result in health benefits through reduced sugar consumption (Fowler et al., 2008).

Another question that arises is what types of people are substituting the taxed soft drinks with other beverages and why? If people switch to a non-caloric beverage, not for health benefits but because it is now cheaper and as a result feel they can consume more food it negates the caloric effect of substitution, which begs the question if a general sugar- or fat- tax might be a better solution from a public health point of view.

Deciding what to tax

Whether diet beverages should be taxed proves to be quite an issue for policy makers. When France introduced their soda-tax they included diet beverages under the pretence that the tax was an excise intended for revenue gain. This caused a federal court to overrule opposing views that a tax was conflicting with EU legislation which was paramount passing the bill. The soda tax bill might not have passed had diet beverages not been included so because if this, if nothing else, an argument for taxing all types of soft drink can be that it avoids legal issues arising in the EU markets with regard to excise taxes.

Public health arguments can be found in studies that suggest artificially sweetened beverages, or diet soft drinks, do not have the suspected dietary advantages because of their calorie-free nature. Some studies suggest that these artificial sweeteners are carcinogenic (Karstadt, 2006).

A study conducted by Fowler et al. (2008) points towards a positive correlation between the consumption of artificially sweetened beverage and the change in body mass index. People that consumed these diet soft drinks experienced increases in body mass index up to 78% greater than the non-users of diet soft drinks.

A separate cohort showed that adoption of this consumption had no significant impact on the change in BMI while the group that discontinued the consumption of artificially sweetened beverages showed a significantly lower increase of BMI over time (Fowler et al., 2008).

A possible explanation may be deducted through the selection-bias problem. An attempt to lose weight might explain the consumption of artificially sweetened beverages, which means the population sample of these users is already likely to consume too many calories per day. Another reason could be that artificial sweeteners can cause a reduced base metabolic rate, lowering overall energy requirements. This can result in a long-term weight gain effect. Another reason that can explain the weight gain is that the calories not consumed through soft drinks are now consumed through other foods and beverages.

The issue whether to tax artificially sweetened beverages for public health reasons remains a controversial one. While Fowler et al. found serious adverse effects, similar studies have not consistently produced the same results (Brownell et al., 2009).

At this time we suggest that all sweetened beverages, both sugar and artificial are taxed and when sufficient studies have shown that artificial sweeteners are not harmful we can decide to remove the tax on them. Additional benefit of taxing all types of soft drinks is the circumvention of EU regulation regarding excise tax.

The effects of reducing overweight on Healthcare Expenditures

To measure the effectiveness of tax policy we should also consider the impact of overweight on the national healthcare expenditures. If we find a relation between taxation and a mean reduction of BMI, does that translate into lower costs? We have found that in the United States cost of obesity and the cost of diet-related diseases is estimated between $71- and $117 billion dollars. Cost of overweight and obesity have been estimated at 9,1% of total healthcare expenditures in the United States (Brownell et al., 2009).

The total cost of healthcare in the Netherlands in 2011 was €89,5 billion, which is 14,9% of the GDP (CBS, Statline), and there is a trend with these costs steadily going up (as a percentage of GDP). Can we find a relationship between the prevalence of overweight and the cost of national healthcare in the Netherlands and consequently estimate a reduction in healthcare expenditures as a result of a tax on sugar-sweetened beverages?

III. Data and Methodology

Data

Contrary to other countries the Netherlands did not have any changes in the taxing of beverages in the last few decades, making any direct estimation very difficult. In France they recently introduced a soda tax, providing nice insights in its impact, especially with regards to price-shifting effects. In the United States tax rates differ between states allowing for an easier access to data for sound analysis. The lack of data on this subject makes it very difficult to estimate effects for the Netherlands, so we are forced to take on a different approach.

There is some data that we have access to, for longitudinal data we can collect data from the Central Bureau for Statistics, CBS Statline[2], and some very basic cross-sectional data on BMI and education levels can be requested from the Data Archiving and Network Service (DANS)[3].

A summary of the descriptive statistics can be found in appendices 9-10. We can see from the table and graphs that there is some skewness and kurtosis[4] in our different variables. We find a positive skewness for hcegdp, where the peaks in the upper ranges can be partially explained by the credit crunch, where a drop in GDP caused the healthcare expenditures as a percentage of GDP to rise. We find similar results when looking at kurtosis, which we find in ln_gdp, relative_price_sd and hcegdp.

Kurtosis in this situations is considered the result of peak variances in a few datapoints as opposed to smaller variances in many datapoints. The peaks in ln_gdp and hcegdp can be explained by the credit crisis, while one reason for the relative price of soft drinks can be the ongoing competitions between the large soft drink producers, which can cause prices to fluctuate.

Methodology

In this section we will use various linear regression models to test our hypotheses. All tests will be performed with a 10% significance level and using these methods we will try to approximate the results found in the other literature.

The lack of empirical data forces us to work with simplified Least Squares estimations that we hope will provide some insight into the Dutch market for soft drink consumption. This way we try to estimate the effects which we can then combine with the literature to make some generalized predictions about the effects of a tax on sweetened beverages for the Netherlands. Shortcomings and recommendations will be discussed in more detail in the limitations section.

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[2] http://statline.cbs.nl/StatWeb/dome/
[3] http://www.dans.knaw.nl/en/content/data-archive/finding-data
[4] We consider data to have skewness and/or kurtosis when the value exceeds 2 std. deviation.

The data for the estimations regarding the other five hypotheses is retrieved from the Central Bureau of Statistics by selecting theme and then search for relevant statistics for periods between 1980-2011, selecting all years for which data was available.

We have taken the variable ‘soft_drink_consumption’ from the consumer spending module and selecting soft drinks. This shows the soft drink consumptions per capita in litres and data is available for 1996 to 2011.

The variable ‘overweight’ shows the percentage of the population that is overweight (with a BMI > 25) so this includes both overweight and obesity. The data is retrieved from the health, lifestyle, healthcare and supply module and data was selected for the period 1981 to 2011.

The ‘Consumer Price Index Soft Drinks’ shows the change in price index of soft drinks over time with a baseline year 2006, ‘Consumer Price Index All Consumption’ shows this statistic for the aggregate average of all consumer goods, with a baseline year 2006. Data was retrieved from the consumer prices module and data was available for 1996 to 2011. We have combined these into one variable which shows the relative price of soft drinks for any given year which we call ‘relative_price_sd’. Note that this is the weighted average price level of all soft drinks, including juices and diet soft drinks. While this does not provide us with great explanatory power it does reduce substitution effects we might see.

In the health, lifestyle, healthcare use and supply module we have selected the cost of care and ‘Costs as a percentage of GDP for which we retrieved annual data from 1980 to 2011. This shows the total cost of healthcare as a percentage of the total GDP which we called ‘hcegdp’.

Lastly we have taken the Gross domestic product from the National Accounts module and selecting GDP value at current prices from 1980 to 2011. We will use this variable as an income control in our estimations for soft drink price levels on consumption. A logarithm of the ‘GDP’ variable was taken which we have called ‘ln_gdp’.

To make sure we are dealing with stationary data we have performed Unit Root Tests on all these variables. The results of the Augmented Dickey-Fuller tests are found in the appendix and as we can see the data is non-stationary. This can be problematic for our analysis so we have taken the first order differences of all relevant variables.

After taking the first order differences we ended up with five new variables which we denoted as d_variable. That means we converted Soft_drink_consumption to 'd_consumption', overweight to 'd_overweight', relative_price_sd to 'd_price', hcegdp to 'd_hcegdp' and Ln_gdp to 'd_lngdp.'

We have checked these new variables for a Unit Root but this time none of the data has a unit root at a 10% significance level. Using this stationary data we can conduct an analysis using several types of autoregressive models.

We have also looked at cointegration between series. For hypotheses 2 and 4 we looked at cointegration between overweight and soft_drink_consumption. For hypothesis 3 we looked at soft_drink_consumption, relative_price_sd and ln_gdp, and for hypothesis 5 we looked at cointegration between overweight, relative_price_sd(-1) and ln_gdp(-1). For hypothesis 6 we looked at hcegdp and overweight. The results are illustrated in appendix 2 to 5.

What we found is that there is no Unit Root in the residuals from the series for hypothesis 2, 3 and 4 and 5 which means that data appears to be stationary. The null hypothesis of a Unit Root in the residuals from the series for hypothesis 6 cannot be rejected, which means we have no stationary data to test them with the usual tools. For hypothesis 6 we will use the first order difference variables that we created and adopt a different model.

Hypothesis 1

"Soft drinks are a large contributor to increased energy intake over the past few years"

Since we do not have data on energy intake in the Netherlands yet we cannot conduct any empirical research regarding this. We will refer to the literature in the theoretical results section, and base our conclusions on the findings in these studies.

Hypotheses 2 and 4

"The increase in Soda consumption is correlated with the increase in overweight"

"A decrease in consumption will reduce overweight"

To identify the correlation between soft drink consumption and overweight prevalence we will try to estimate the effects using a simple regression model using Least Squares estimation. We will consider a basic model where we look at overweight and consumption with gdp as a control. We will also consider a lagged model because we argue that there is a lag in overweight, and consumption now will affect body weight in the future. Equation 1 is our basic model, with data from 1981 to 2009 and equation 2 is our lagged model with data from 1982 to 2010.

1) $overweight_t = \beta_0 + \beta_1 consumption_t + \beta_2 \ln\_gdp_t + \varepsilon$
2) $overweight_t = \beta_0 + \beta_1 consumption_{t-1} + \beta_2 \ln\_gdp_{t-1} + \varepsilon$

Hypothesis 3

"An increase of tax will reduce the consumption of sugar-sweetened beverages"

Because we lack data in the Netherlands on the changes in tax rates, the estimations will be derived from the effect of changes in price level. We argue that when a change in price affects consumption the tax induced price change must therefore affect consumption. The real effect of the tax cannot be known because we do not know anything about price shifting effects, but seeing how the soda tax in France was fully passed through on to consumers (Berardi et al., 2012) we will assume it does so as well in the Netherlands and try to estimate the effects..

We have previously operationalized the relative Soft Drink Price and what we can see from the data is that Soft Drink, relative to normal price levels, has become cheaper over the years so we would expect to see a rise in consumption because of that.

We will also include ln_gdp to account for income effects since we would expect that an increase in income also affects consumption. This results in the following model, with data from 1996 to 2009:

$$soft\_drink\_consumption_t = \beta_0 + \beta_1 relative\_price\_sd_t + \beta_2 ln\_gdp_t + \varepsilon$$

Theoretical methodology concerning Hypothesis 3.

Tefft (2008) looked at the effects of a soft drink tax on the household expenditures (Y_i^{*}), for this he used a model which controls for fixed effects and looks as follows.

$$Y_i^* = \beta_0 + \beta_\tau \tau_s + \beta_x X_i + \beta_m M_i + \delta_y + \eta_q + \gamma_g + \epsilon_i$$

β denotes the vectors, τ the level of soft drink tax, X_i are demographic characteristics, M_i is the household income and δ_y η_q γ_g are the fixed effects (Tefft, 2008). Using Ordinary least Squares, probit and Quantile regression models he tried to estimate the effects of a soft drink tax on the total household expenditures.

Smith et al. (2010) studied the effect of taxing sugar sweetened beverages with regard to consumption, caloric intake and overweight. They used a dataset on grocery shopping to create a demand curve, and this demand curve was applied to a dataset on beverage consumption to simulate the effects of a tax.

Hypothesis 5

"An increase of the tax will reduce overweight"

We will make a model with change in overweight as a result from the change of relative soft drink prices and we will add income effects. We predict that relative prices will affect consumption and consumption will affect overweight. Hence we will try to find out if we can establish a direct relation between the price of soft drink and overweight. As with previous models we will use the lagged terms of price and gdp as overweight is not an instant result of consumption but rather a lagged effect from overconsumption. The model below was used with data from 1997 to 2011.

$$overweight_t = \beta_0 + \beta_1 relative\_price\_sd_{t-1} + \beta_2 ln\_gdp_{t-1} + \varepsilon$$

Theoretical methodology concerning hypothesis 5

We will also consider the model made by Schroeter et al (2008) which is an elasticity model to estimate the effects of a soft drink tax on the change in individual body weight.

This is a Utility maximizing framework where utility is derived from consumption and bodyweight, which itself is derived from consumption and exercise. The model below is derived from the underlying elasticities and shows the weight change in percentages as a result from changes in the price of High Calorie Food F^H, Low calorie Food F^L and exercise E.

$$\widehat{W} = \hat{p}_{F^{H1}}\big(\epsilon_{WF^{H1}}\varepsilon_{H1H1}+\ldots+\epsilon_{WF^{Hi}}\epsilon_{HiH1} + \epsilon_{WF^{L1}}\epsilon_{L1H1}+\ldots+\epsilon_{WF^{Ln}}\epsilon_{LnH1} + \epsilon_{WE}\epsilon_{EH1}\big)+\ldots+\hat{p}_{F^{Hi}}\big(\epsilon_{WF^{H1}}\varepsilon_{H1Hi}+\ldots+\epsilon_{WF^{Hi}}\epsilon_{HiHi} + \epsilon_{WF^{L1}}\epsilon_{L1H1}+\ldots+\epsilon_{WF^{Ln}}\epsilon_{LnHi} + \epsilon_{WE}\epsilon_{EHi}\big)$$ [5]

Using energy accounting and data on daily consumption and exercise they have estimated the average weight loss as a result from taxation for the United States. Cross price elasticities were taken from Dhar et al. (2003) and is included in the appendix section

Hypothesis 6

"Lowering the prevalence of overweight will reduce the cost of healthcare"

To estimate the effects of the prevalence of overweight on Healthcare expenditures we will use an AutoRegressive Distributive Lag Model with d_hcegdp as the dependent variable. The constant c, which can be seen as the slope of the curve is not significant so we reworked the model to have only significant variables. To avoid further trending and autocorrelation we look at the healthcare expenditures with 1 time lag. Overweight at first was not significant which makes sense because of time lags. The cost of healthcare is based on previous health indicators as the consumption of healthcare is reactive, so we have used a time-lagged overweight variable. We will consider the following model.

$$d\_hcegdp_t = \beta_1 d\_hcegdp_{t-1} + \beta_2 d\_overweight_{t-1} + \varepsilon$$

[5] *Schroeter et al. (2008)*

IV. Results

In this chapter we will discuss the results from our studies. In the first part we will review the outcomes of the literature. The outcomes that are most relevant for our study are the model Tefft (2008), the model by Schroeter, Lusk and Tyner (2007) and the literature by Berardi et al. (2012) which studied the effects of the soda tax in France. In the second part we will review our own empirical work to see if we can get similar results as the literature. Using the combined results we will attempt to draw some generalized conclusions.

Theoretical results:

Hypothesis 1

"Soft drinks are a large contributor to increased energy intake over the past few years"

To find an answer to this question we looked at a study by Block (2004) who looked at national Health and Nutrition Examination Surveys, and Vartanian et al. (2007) and Malik et al.(2006) who both reviewed studies regarding the relation between the consumption of Sugar Sweetened beverages and daily energy intake.

In her study, Block found that soft drink consumption is the largest contributor to the daily intake of energy, and a combination of soft drinks and fruit juices made up for 9 percent of the total daily energy intake. Furthermore she found that soft drinks contribute more to the daily energy intake than a decade before (Block, 2004).

Vartanian et al. (2007) found that there is a clear association between the consumption of sugar sweetened beverages and the intake of energy. They concluded that people do not compensate the energy from drinks with other meals which results in overconsumption. Malik et al. (2006) used similar research methods and got similar results. They found a positive relation between the consumption of sugar sweetened beverages and overweight in both children and adults. The total contribution of added sugars toward the daily energy intake is estimated at 15,8 percent with beverages being the largest contributor. Additionally they saw an increase of soft drink consumption of 135 percent between 1977 and 2001 (Malik et al., 2006).

Throughout these studies we find consistent results that show a strong relation between the consumption of soft drinks and the intake of daily energy. Based on this we can conclude that Soft drinks are large contributors to the increased energy intake over the past few years.

Hypothesis 3

"An increase of tax will reduce the consumption of soft drinks"

Tefft (2008) found that a tax induced increase of the soft drink price by 10 percent resulted in a decline in household expenditures and due to the increased price of the products he argues that this implies an even stronger decline in the consumption of soft drinks. An increase of the tax rate can be a very effective policy measure according to him.

Smith et al (2010) concluded based on their studies that a tax induced price increase of sugar sweetened beverages can lead to a decline in overweight and obesity. They found a very strong price elasticity of -1,264 which means a tax increase of 20 percent will reduce overall consumption by more than 25 percent. This effect was very strong and barely compensated by substitution effects, resulting in a decline in consumption and daily caloric intake. While the effect found by Smith is very strong it is in line with other studies, like the one by Andreyeva et al. (2010) who found that a 10 percent price increase results in a decreased consumption of 8 to 10 percent.

Throughout these studies we find consisting results that taxation is an effective measure for reducing soft drink consumption and while price elasticities vary between studies they all show that soft drinks are a fairly elastic product which is strongly influenced by price changes. According to the theoretical results we are inclined to accept the hypothesis that an increase of tax will reduce the consumption of soft drinks.

Hypothesis 5

"An increase of the tax will reduce overweight"

Schroeter et al. (2008) found a significant effect of a tax increase on the reduction of overweight albeit a small effect. An increase of the tax on caloric soft drinks by 10 percent results in a weight loss of 0,099 percent for males and 0,122 percent for females. Due to the restrictions in this model they suspect that a tax will be more effective than these numbers but given the significant effect we can conclude that a tax increase will reduce overweight.

Tax revenues

The total soft drink excise revenue for 2009 was €93,12 Million. The total Ad valorem tax cannot be specified because average prices vary between the retail- and food service industry. Total consumption in 2009 was 1693,5 Million litres so at an estimated €1 per litre of soft drink that would roughly equal ~€102 million in Ad Valorem tax revenues.

In this paper we have discussed the different effects that tax has on consumption, we suggest that an increase in the excise tax of both sugar- and artificially sweetened beverages is coupled with the abolishment of the excise tax on mineral water. This means that between substitution effects, price elasticity effects, abolishment of excise tax on mineral waters, and the pass-through effects, the aggregate effect of a tax increase on revenues is multi-dimensional and hard to estimate for the Netherlands.

Pensions

Another effect that might come into play is the change in pension payments. Overweight and obesity reduce life expectancy by ~3,2 and 6,5 years respectively (Peeters et al., 2003) so a reduction of these will result in people living longer. Living longer has an effect on pensions and while we cannot estimate the effect in this paper we have to mention it since it will most likely have an effect in some way. More research is needed on this topic to properly assess the impact on pensions.

Empirical results:

Hypotheses 2 and 4

The results of our simple regression Model using Least Squares estimation on the relation between soft drink consumption and overweight prevalence are illustrated on the next page.

1) $overweight_t = \beta_0 + \beta_1 consumption_t + \beta_2 \ln\_gdp_t + \varepsilon$
2) $overweight_t = \beta_0 + \beta_1 consumption_{t-1} + \beta_2 \ln\_gdp_{t-1} + \varepsilon$

Dependent Variable: OVERWEIGHT
Method: Least Squares
Sample (adjusted): 1981 2009
Included observations: 29 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-75.03911	13.98518	-5.365617	0.0000
SOFT_DRINK_CONSUMPTION	0.105126	0.033433	3.144331	0.0041
LN_GDP	7.917494	1.307967	6.053281	0.0000

R-squared	0.987208	Mean dependent var	33.56552
Adjusted R-squared	0.986224	S.D. dependent var	4.885640
S.E. of regression	0.573427	Akaike info criterion	1.823326
Sum squared resid	8.549290	Schwarz criterion	1.964770
Log likelihood	-23.43823	Hannan-Quinn criter.	1.867625
F-statistic	1003.282	Durbin-Watson stat	1.665617
Prob(F-statistic)	0.000000		

Dependent Variable: OVERWEIGHT
Method: Least Squares
Sample (adjusted): 1982 2010
Included observations: 29 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-84.06609	14.43893	-5.822181	0.0000
SOFT_DRINK_CONSUMPTION(-1)	0.087730	0.034518	2.541557	0.0173
LN_GDP(-1)	8.777916	1.350405	6.500210	0.0000

R-squared	0.986782	Mean dependent var	34.05862
Adjusted R-squared	0.985765	S.D. dependent var	4.962180
S.E. of regression	0.592032	Akaike info criterion	1.887186
Sum squared resid	9.113061	Schwarz criterion	2.028631
Log likelihood	-24.36420	Hannan-Quinn criter.	1.931485
F-statistic	970.5175	Durbin-Watson stat	2.211053
Prob(F-statistic)	0.000000		

Looking at these outputs we can see that all variables are significant, and while it is not perfect, we can reject the presence of autocorrelation[6]. Considering our premise that there is a lagged effect between consumption and overweight we prefer the second model.

Soft_drink_consumption has a coefficient of 0,08773. This means that in our model about ~8,77% of the value of consumption contributes to the change in overweight. The coefficient is positive as is the coefficient for ln_gdp which means an increase in either or both will result in higher overweight prevalence. The income effects are much larger than the consumption effects however, and this is consistent with the literature.

We can also see that with an R-squared of 0,9868, approximately 98,68% of the relation is explained by the soft drink consumption and income. This can be a problem because an R-squared above 0,90 could be indicative of a lack of variation[7]. Another reason can be found in homogeneity of variance, so we performed ARCH tests. We found homoskedasticity in our residuals which can also explain the high R-squared, the results of the ARCH tests are found in appendices 11-14. Because we have limited data and no sudden changes this is an expected result, but not an ideal one.

We have also estimated the effects without a control for ln_gdp which also results in a positive significant effect of a lagged consumption on overweight. This model can be found in appendix 6.

As a result of these outcomes we will accept hypothesis 2 that consumption is correlated with overweight prevalence and consequently we will accept hypothesis 4 that a reduction in consumption will reduce the growth of overweight prevalence.

Hypothesis 3

The simple regression model using the Least Squares estimation approach on the model below is illustrated in this output. Note that relative_price_SD has data from 1996 to 2011, and soft_drink_consuption has data from 1980 to 2009, so we are left with only 14 observations. From 1996 to 2009.

$$soft\_drink\_consumption_t = \beta_0 + \beta_1 relative\_price\_sd_t + \beta_2 \ln\_gdp_t + \varepsilon$$

[6] We reject the presence of autocorrelation when the Durbin-Watson stat. Is 1.60-2.40.
[7] Carpenter and Cook (2007) suggest an R-squared upward of 0,90 is problematic.

Dependent Variable: SOFT_DRINK_CONSUMPTION
Method: Least Squares
Sample (adjusted): 1996 2009
Included observations: 14 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-432.7509	88.89319	-4.868212	0.0005
RELATIVE_PRICE_SD	26.84531	13.19611	2.034335	0.0668
LN_GDP	38.12042	5.892834	6.468945	0.0000

R-squared	0.866502	Mean dependent var	93.40000
Adjusted R-squared	0.842229	S.D. dependent var	6.299451
S.E. of regression	2.502164	Akaike info criterion	4.859598
Sum squared resid	68.86904	Schwarz criterion	4.996539
Log likelihood	-31.01719	Hannan-Quinn criter.	4.846922
F-statistic	35.69906	Durbin-Watson stat	2.055549
Prob(F-statistic)	0.000015		

We can see from this output that soft drink consumption is correlated with the relative price of soft drinks and the national income. Relative price is significant at a 10% level while income is significant even at a 1% level. This is consistent with findings in other literature and with this R-squared we stay below the critical value of 0,90. This would suggest that income and price are the most important factors in deciding the amount of soft drink consumption. An interesting result is the positive coefficient for relative price, which suggests that either an increase in relative price will increase consumption, or the increase in consumption increases the price. An increase in price as a result of increased consumption is in accordance with the Law of Demand, when demand goes up the price goes up, so this is an expected outcome. We have also considered a more simplistic model where we only look at the relative price of soft drinks and there we find that the effect is significant and the coefficient is negative, which contradicts our previous findings. In this model we found autocorrelation however, which can be a problem when making estimations. The output of this model can be found in appendix 7.

Based on this model we will reject H3 with the addition that we have to consider the literature in the theoretical results section, or future research on changes in tax rates. It would appear that we cannot use the natural price levels as an estimator for consumption since we cannot establish a causal time order.

Hypothesis 5

Results from the least squares model with least Squares estimation on the equation below provides estimates to test our hypothesis. The model is quite similar to the model used for hypothesis 3, but because we found a relation between price and consumption, and between consumption and overweight we now want to test the direct relation between price and overweight. We use the same lagged model here to keep the timeframes consistent.

$$overweight_t = \beta_0 + \beta_1 relative\_price\_sd_{t-1} + \beta_2 ln\_gdp_{t-1} + \varepsilon$$

Dependent Variable: OVERWEIGHT
Method: Least Squares
Sample (adjusted): 1997 2011
Included observations: 15 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-140.0059	20.67923	-6.770366	0.0000
RELATIVE_PRICE_SD(-1)	7.900064	3.145403	2.511622	0.0273
LN_GDP(-1)	13.04362	1.362583	9.572723	0.0000

R-squared	0.936473	Mean dependent var	38.80000
Adjusted R-squared	0.925885	S.D. dependent var	2.198051
S.E. of regression	0.598400	Akaike info criterion	1.987741
Sum squared resid	4.296988	Schwarz criterion	2.129351
Log likelihood	-11.90806	Hannan-Quinn criter.	1.986233
F-statistic	88.44756	Durbin-Watson stat	2.262159
Prob(F-statistic)	0.000000		

As with the model outcomes from hypothesis 3, we find a positive relation between the price of soft drinks and overweigh. From our base assumption that price affects consumption it is unlikely that higher prices will increase overweight prevalence. When we assume that an increase in consumption will increase the price, we have to look at income effects and we suspect that ln_gdp distorts our estimations. When we remove it from the model we find a negative coefficient for relative_price_sd, this can be seen in appendix 8.

These results mean that it is worth looking into these effects more thoroughly once usable data becomes available. For now our results regarding the effect of a soft drink tax on overweight prevalence remain inconclusive. For further testing of hypothesis 5, we will look at Schroeter et al (2008).

Hypothesis 6

The last hypothesis is tested with the Auto Regressive Redistributed Lag Model using the equation below to look at the effect of overweight on the healthcare expenditures. The outcomes are illustrated in the output.

$$d\_hcegdp_t = \beta_1 d\_hcegdp_{t-1} + \beta_2 d\_overweight_{t-1} + \varepsilon$$

Dependent Variable: D_HCEGDP
Method: Least Squares
Sample (adjusted): 1983 2011
Included observations: 29 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D_HCEGDP(-1)	0.435447	0.159892	2.723377	0.0112
D_OVERWEIGHT(-1)	0.109513	0.062863	1.742105	0.0929

R-squared	0.217325	Mean dependent var	0.127586
Adjusted R-squared	0.188337	S.D. dependent var	0.339008
S.E. of regression	0.305420	Akaike info criterion	0.532214
Sum squared resid	2.518595	Schwarz criterion	0.626510
Log likelihood	-5.717098	Hannan-Quinn criter.	0.561746
Durbin-Watson stat	1.722872		

As we can see our variable of interest is significant at a 10% level and has a positive coefficient. This means that the prevalence of Overweight in a previous time t contributes to the growth of healthcare expenditures. As a result we will accept hypothesis 6, and conclude that a reduction in overweight will in fact reduce the growth of healthcare expenditures as a percentage of GDP.

V. Conclusion

We have seen that soft drink consumption has an added negative effect on energy intake. Vartanian et al. (2007)showed that soft drink consumers have an average daily energy intake that is 17% higher than non-consumers. And this added energy could not be explained by the energy from soft drinks alone. We have also seen that soft drink consumption follows a similar trend as the obesity statistic. While this correlation does not prove anything, it does show, combined with the increase in ‘foods away from home, a change in food consumption behaviour over the years. And obesity and overweight could very well be a result of this change.

Soft drink price elasticitities vary greatly between studies and where Zheng finds a relatively inelastic relation of -1,51 percent for a 10% tax increase, Andreyeva et al. and Duffey et al. estimate energy from soft drink elasticity between -7% and -10% for a 10% tax increase. One limitation they all share is that they did not account for different levels of income. If the low income group consumes more soft drinks than the middle and high incomes a tax, which is regressive by nature, will hit them harder and this could amplify the effects.

We have found different estimations of the effect of a tax on overweight throughout the literature. Smith et al. estimate that a tax increase of 20%, which is not very realistic, lowers consumption by 37 calories a day which translates to 3,8 pounds per year using energy accounting. This value is very extreme and only shows a Difference in difference effect. It shows that a person consuming less will weigh less than he otherwise would have done, it does not mean this is the weight a person will actually lose, for weight loss to occur one needs to spend more calories that one consumes, as we have also seen in the model for energy accounting (Whitney, 2002). The arguments made are that most people are only slightly overweight and only slightly over consume, and that it is the people who are overweight that consume a lot of soft drink, making the tax very effective.

Less optimistic estimations are made by Schroeter et al. and Fletcher et al. Based on a 10% tax Schroeter estimates a weight loss of 0,01% and 0,122% for men and women respectively, while Fletcher estimates an average BMI reduction of 0,03%. Based on average weight and BMI statistics in the Netherlands both result is roughly the same outcomes, which are very small. This is explained by substitution effects that cause people to substitute soft drinks for other caloric beverages e.g. juice and milk, and for solid foods to compensate for a loss of calorie intake.

We consider the previous effects to be mostly related to tax and consumption so we will also look at the costs and benefits of a tax. We have seen that overweight has influence on the healthcare expenditures, so reducing the percentage of people that are overweight through taxation could also reduce the increase in health care expenditures. The precise effect of tax on expenditures could not be studied in this paper, but we have shown an indirect effect from tax on healthcare expenditures through tax on consumption, consumption on overweight and overweight on healthcare expenditures.

Due to the complex nature of this subject, it is very difficult to estimate the increase in tax revenues for the government, as we have discussed. Another tax related issue is the type of tax that needs to be induced. Increasing the V.A.T from 6% to 21% (ad valorem) will avoid any EU legislation and would not affect the existing tax on beverages, where an increase in excise tax on soft drinks will face some legal difficulties. Especially when mineral water and diet drinks are no longer taxed. A benefit of the excise tax opposed to an ad valorem tax however, is that excise taxes do not suffer from pricing strategies as much, and excise tax potentially generates more total revenue for governments. Both taxes are regressive in nature which means the lower incomes will be hit harder by them than middle and higher incomes.

Effects that have been underexposed in this paper but are worth mentioning are the effects on the Soft Drink industry. The industry might start producing different products, move their business to other parts of the world, or slim down. A loss of margin might result in unemployment for people working in this industry.

Another effect regards the pensions. All literature we reviewed is in agreement that soft drink consumption can lead to overweight and obesity. Overweight and obesity result in lower life expectancy (peters et al., 2003) so if the tax results in life expectancy going up than pensions will have to be paid longer, and new estimations will have to me made regarding that change.

The model that we discussed in this paper is twofold, the first part is a public health model with health effects, and the second part is an economic model with economic effects. This multidimensional problems calls for thorough research before implementing new policies. We would like to stress however that there is ample reason to act, because overweight and obesity are becoming a problem and soft drink consumption is making it worse. There is a distinct market failure present and as we have seen in this paper, over consumption leads to externalities which cause the consumers of soft drinks to not bear the full burden of the costs. Just like the Tobacco industry, taxation is a solution that is worth considering. It is a cheap and easy policy measure, and if it does not reduce consumption as much, it will generate more tax revenues which can be spend on healthcare or subsidizing healthy foods. It is not the only solution, and soft drink consumption is not the only problem, but we will have to start somewhere.

If we adopt the statistics from the United States we can see that in the future 9,1% of all healthcare expenditures are a result of overweight related illnesses. Using the data from 2011 which showed total healthcare expenditures in the Netherlands at €89,5 billion, a quick deduction indicates that around €8,1 billion is a result of overweight related illnesses. The biggest priority here is to reduce overweight and reducing these costs rather than increasing tax revenues, and because 1,36%[8] of the total GDP is spent on overweight related illnesses, not to mention additional effects through lower productivity this is a very important issue that merits more study.

VI. Limitations

The way this research has been conducted has presented several limitations. Firstly there is a lack of available data. The initial idea was to use data and models from an existing case of tax increases, like separate states in the United States or France. We intended to use either regression discontinuity or Difference in Difference designs. Through this we wanted to use the soft drink tax as an instrumental variable, similarly to the research done on the tobacco excises and public health.

The quality of the data was also questionable because we found some skewness, kurtosis and homoskedasticity, which can affect our estimations.

We have found throughout our research that we cannot apply the techniques used in those models as a result of either methodological or empirical limitations. In the United States they compared different states with each other which is something we could not do for the Netherlands. The study on the soft drink tax in France uses very exclusively acquired data from large retailers.

While some of the relevant data will exist in private databanks we did not have access to this, which bound our research to a small scale longitudinal study with a limited

[8] 9,1% of 14,9% is ~1,36%.

sample size. We believe that this study offers a decent platform for future studies, with more available data, to expand on and provide more definite answers to the questions regarding soft drink taxation.

As a result we could not estimate any pass-through effects of tax, making the price on overweight estimations less precise, and throughout all of the estimations there is a general absence of causality. We have shown the relationships between the different variables but we lack the data and the tools to confirm causality.

The last limitation is a personal bias we have found with ourselves toward implementing this soft drink tax. While efforts have been made to be as unbiased as possible it is worth mentioning that most studies on this subject tend to be positively biased toward taxation and as a result mostly focus on the (health) benefits and underemphasize any drawbacks a tax might present.

A suggestion for further research then, is to have this research conducted when sufficient data becomes available. Then a more extensive model can be built with the aim of getting more conclusive results. Furthermore we would suggest future research to focus more heavily on perceived negative effects. And as we have shown there are possible indirect effects on pensions and healthcare expenditures that go beyond the more direct effects of taxation on overweight which is worth researching considering the magnitude of the issue.

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Appendix

Augmented Dickey-Fuller Unit Root Test

Null Hypothesis: HCEGDP has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.046108	0.9555
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

Null Hypothesis: LN_GDP has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.921772	0.7672
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

Null Hypothesis: SOFT_DRINK_CONSUMPTION has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.107654	0.9395
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

Null Hypothesis: RELATIVE_PRICE_SD has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=3)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.224214	0.6365
Test critical values:	1% level	-3.920350	
	5% level	-3.065585	
	10% level	-2.673459	

Null Hypothesis: OVERWEIGHT has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.059884	0.9449
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

Appendix 1: Unit Root test for all five relevant variables.

Null Hypothesis: RESID_H2H4 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=6)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.166812	0.0330
Test critical values:	1% level	-3.689194	
	5% level	-2.971853	
	10% level	-2.625121	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RESID_H2H4)
Method: Least Squares
Date: 08/07/13 Time: 13:55
Sample (adjusted): 1982 2009
Included observations: 28 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID_H2H4(-1)	-0.555358	0.175368	-3.166812	0.0039
C	0.010778	0.150371	0.071674	0.9434

R-squared	0.278353	Mean dependent var	0.012887
Adjusted R-squared	0.250597	S.D. dependent var	0.919140
S.E. of regression	0.795681	Akaike info criterion	2.449513
Sum squared resid	16.46083	Schwarz criterion	2.544671
Log likelihood	-32.29318	Hannan-Quinn criter.	2.478604
F-statistic	10.02870	Durbin-Watson stat	2.120439
Prob(F-statistic)	0.003911		

Appendix 2: Unit Root test for residuals. Series: overweight, soft_drink_consumption. Critical value (10%): -3.04

Null Hypothesis: RESID_H3 has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=2)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.965627	0.0129
Test critical values:	1% level	-4.121990	
	5% level	-3.144920	
	10% level	-2.713751	

*MacKinnon (1996) one-sided p-values.
Warning: Probabilities and critical values calculated for 20 observations and may not be accurate for a sample size of 12

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RESID_H3)
Method: Least Squares
Date: 08/07/13 Time: 14:00
Sample (adjusted): 1998 2009
Included observations: 12 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID_H3(-1)	-1.633047	0.411800	-3.965627	0.0033
D(RESID_H3(-1))	0.552515	0.286431	1.928965	0.0858
C	0.068746	0.633709	0.108482	0.9160

R-squared	0.660091	Mean dependent var	0.064019
Adjusted R-squared	0.584556	S.D. dependent var	3.405836
S.E. of regression	2.195229	Akaike info criterion	4.622768
Sum squared resid	43.37129	Schwarz criterion	4.743995
Log likelihood	-24.73661	Hannan-Quinn criter.	4.577886
F-statistic	8.738848	Durbin-Watson stat	1.695391
Prob(F-statistic)	0.007783		

Appendix 3: Unit Root test for residuals. Series: soft_drink_consumption, relative_price_sd, ln_gdp. Critical value (10%): -3.45

Null Hypothesis: RESID_HYP5 has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=3)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.083688	0.0106
Test critical values:	1% level	-4.121990	
	5% level	-3.144920	
	10% level	-2.713751	

*MacKinnon (1996) one-sided p-values.
Warning: Probabilities and critical values calculated for 20 observations
and may not be accurate for a sample size of 12

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RESID_HYP5)
Method: Least Squares
Sample (adjusted): 2000 2011
Included observations: 12 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID_HYP5(-1)	-2.190064	0.536296	-4.083688	0.0035
D(RESID_HYP5(-1))	0.933913	0.410225	2.276585	0.0523
D(RESID_HYP5(-2))	0.674310	0.271244	2.485989	0.0378
C	0.016546	0.145885	0.113417	0.9125

R-squared	0.762780	Mean dependent var	0.027074
Adjusted R-squared	0.673823	S.D. dependent var	0.871825
S.E. of regression	0.497916	Akaike info criterion	1.704431
Sum squared resid	1.983364	Schwarz criterion	1.866067
Log likelihood	-6.226588	Hannan-Quinn criter.	1.644588
F-statistic	8.574668	Durbin-Watson stat	2.208050
Prob(F-statistic)	0.007013		

Appendix 4: Unit Root test for residuals. Series: overweight, relative_price_sd(-1), ln_gdp(-1). Critical value (10%): -3.45

Null Hypothesis: RESID_H6 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.903702	0.7731
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RESID_H6)
Method: Least Squares
Date: 08/08/13 Time: 10:21
Sample (adjusted): 1982 2011
Included observations: 30 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID_H6(-1)	-0.099431	0.110027	-0.903702	0.3739
C	0.029918	0.068890	0.434285	0.6674

R-squared	0.028340	Mean dependent var	0.034357
Adjusted R-squared	-0.006362	S.D. dependent var	0.375173
S.E. of regression	0.376365	Akaike info criterion	0.947823
Sum squared resid	3.966207	Schwarz criterion	1.041236
Log likelihood	-12.21735	Hannan-Quinn criter.	0.977707
F-statistic	0.816678	Durbin-Watson stat	1.630004
Prob(F-statistic)	0.373863		

Appendix 5: Unit Root test for residuals. Series: hcegdp, overweight.

Critical value (10%): -3.04

Dependent Variable: OVERWEIGHT
Method: Least Squares
Sample (adjusted): 1981 2010
Included observations: 30 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.608856	0.861618	11.15211	0.0000
SOFT_DRINK_CONSUMPTION(-1)	0.308556	0.010759	28.67883	0.0000

R-squared	0.967077	Mean dependent var	33.83667
Adjusted R-squared	0.965901	S.D. dependent var	5.025143
S.E. of regression	0.927933	Akaike info criterion	2.752625
Sum squared resid	24.10966	Schwarz criterion	2.846039
Log likelihood	-39.28938	Hannan-Quinn criter.	2.782509
F-statistic	822.4754	Durbin-Watson stat	1.931719
Prob(F-statistic)	0.000000		

Appendix 6: The LS estimates of the H2 H4 model using only soft drink consumption.

Dependent Variable: SOFT_DRINK_CONSUMPTION
Method: Least Squares
Sample (adjusted): 1996 2009
Included observations: 14 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	139.6393	17.90542	7.798716	0.0000
RELATIVE_PRICE_SD	-42.19244	16.28809	-2.590386	0.0236

R-squared	0.358635	Mean dependent var	93.40000
Adjusted R-squared	0.305188	S.D. dependent var	6.299451
S.E. of regression	5.250930	Akaike info criterion	6.286251
Sum squared resid	330.8672	Schwarz criterion	6.377545
Log likelihood	-42.00376	Hannan-Quinn criter.	6.277800
F-statistic	6.710102	Durbin-Watson stat	0.724790
Prob(F-statistic)	0.023641		

Appendix 7: The LS estimates of the H3 model using only relative soft drink prices.

Dependent Variable: OVERWEIGHT
Method: Least Squares
Sample (adjusted): 1997 2011
Included observations: 15 after adjustments

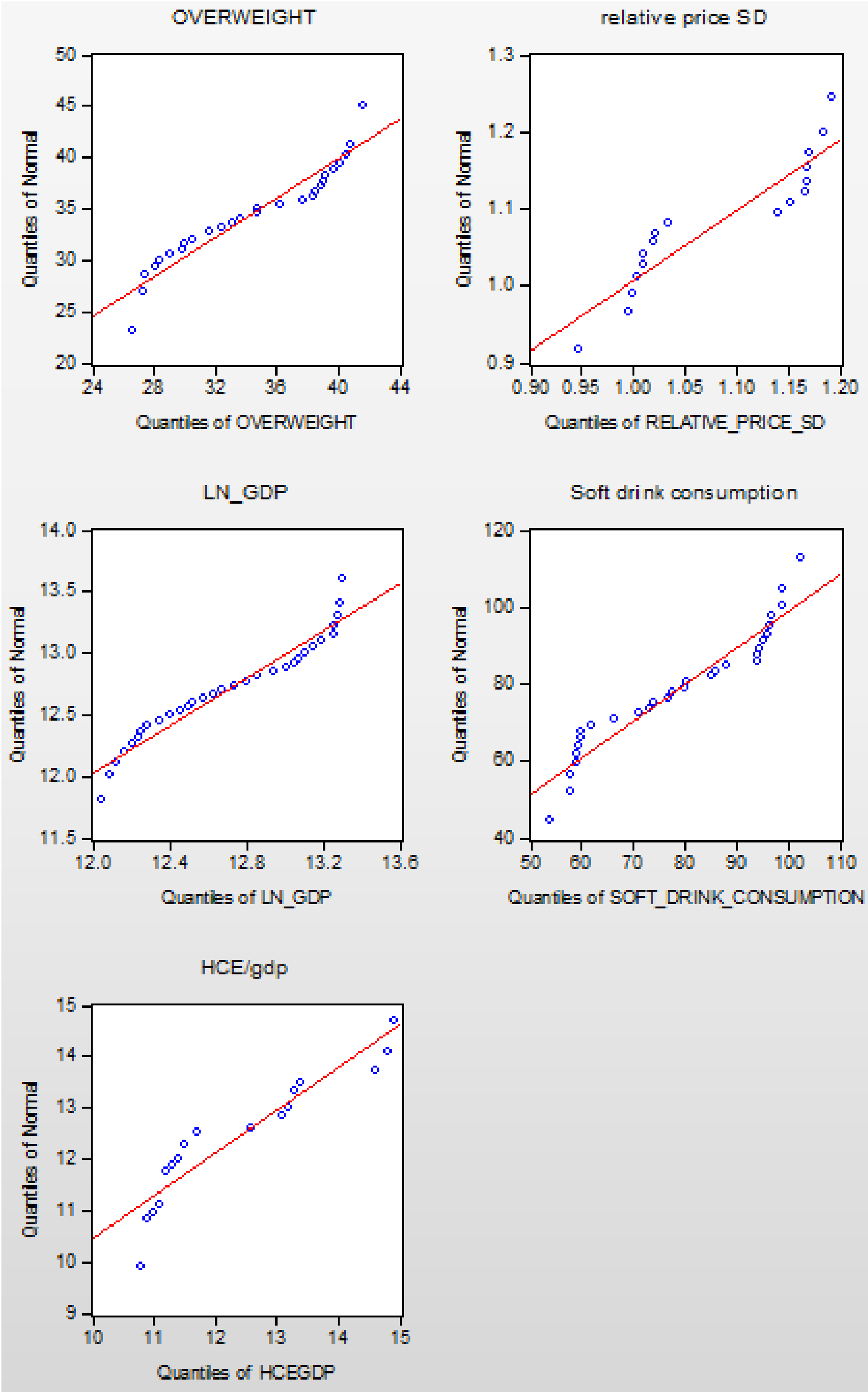
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	57.03978	5.594507	10.19568	0.0000
RELATIVE_PRICE_SD(-1)	-16.71993	5.112725	-3.270258	0.0061

R-squared	0.451352	Mean dependent var	38.80000
Adjusted R-squared	0.409148	S.D. dependent var	2.198051
S.E. of regression	1.689574	Akaike info criterion	4.010396
Sum squared resid	37.11058	Schwarz criterion	4.104802
Log likelihood	-28.07797	Hannan-Quinn criter.	4.009390
F-statistic	10.69459	Durbin-Watson stat	0.607324
Prob(F-statistic)	0.006086		

Appendix 8: The LS estimates of the H5 model using only relative soft drink prices.

	OVERWEIGHT	**RELATIVE_PRICE_SD**	**LN_GDP**	**SOFT_DRINK_CONSUMPTION**	**HCEGDP**
Mean	34.090	1.082	12.706	78.520	11.980
Median	33.700	1.035	12.675	78.850	11.400
Maximum	41.700	1.192	13.307	102.700	14.900
Minimum	26.700	0.947	12.046	53.800	10.800
Std. Dev.	5.139	0.087	0.4222	16.015	1.261
Skewness	0.016	0.029	-0.002	-0.065	1.079
Kurtosis	1.508	1.276	1.579	1.513	2.888
Jarque-Bera	2.877	2.107	2.606	2.784	6.031
Probability	0.237	0.349	0.271	0.248	0.049
Sum	1056.800	18.389	393.894	2355.600	371.400
Sum Sq. Dev.	792.147	0.120	5.349	7438.548	47.708
Observations	31	17	31	30	31

Appendix 9: Summary Statistics.



Appendix 10: Distribution graph for all variables used

Heteroskedasticity Test: ARCH

F-statistic	0.240374	Prob. F(1,26)	0.6280
Obs*R-squared	0.256493	Prob. Chi-Square(1)	0.6125

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Sample (adjusted): 1982 2009
Included observations: 28 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.312647	0.111771	2.797216	0.0096
RESID^2(-1)	-0.095589	0.194969	-0.490280	0.6280

R-squared	0.009160	Mean dependent var	0.283475
Adjusted R-squared	-0.028949	S.D. dependent var	0.493571
S.E. of regression	0.500664	Akaike info criterion	1.522987
Sum squared resid	6.517283	Schwarz criterion	1.618145
Log likelihood	-19.32182	Hannan-Quinn criter.	1.552078
F-statistic	0.240374	Durbin-Watson stat	2.005267
Prob(F-statistic)	0.628048		

Appendix 11: ARCH-test for residuals hypotheses 2 and 4

Heteroskedasticity Test: ARCH

F-statistic	0.086089	Prob. F(1,11)	0.7747
Obs*R-squared	0.100952	Prob. Chi-Square(1)	0.7507

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Sample (adjusted): 1997 2009
Included observations: 13 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.334769	2.707569	1.970317	0.0745
RESID^2(-1)	-0.088119	0.300328	-0.293410	0.7747

R-squared	0.007766	Mean dependent var	4.901658
Adjusted R-squared	-0.082438	S.D. dependent var	7.866050
S.E. of regression	8.183859	Akaike info criterion	7.182843
Sum squared resid	736.7310	Schwarz criterion	7.269758
Log likelihood	-44.68848	Hannan-Quinn criter.	7.164978
F-statistic	0.086089	Durbin-Watson stat	2.002729
Prob(F-statistic)	0.774671		

Appendix 12: ARCH-test for residuals hypothesis 3

Heteroskedasticity Test: ARCH

F-statistic	0.097114	Prob. F(1,12)	0.7607
Obs*R-squared	0.112390	Prob. Chi-Square(1)	0.7374

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Sample (adjusted): 1998 2011
Included observations: 14 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.332303	0.120044	2.768175	0.0170
RESID^2(-1)	-0.087790	0.281711	-0.311631	0.7607

R-squared	0.008028	Mean dependent var	0.306117
Adjusted R-squared	-0.074636	S.D. dependent var	0.309440
S.E. of regression	0.320780	Akaike info criterion	0.695441
Sum squared resid	1.234797	Schwarz criterion	0.786734
Log likelihood	-2.868084	Hannan-Quinn criter.	0.686990
F-statistic	0.097114	Durbin-Watson stat	1.831025
Prob(F-statistic)	0.760669		

Appendix 13: ARCH-test for residuals hypothesis 5

Heteroskedasticity Test: ARCH

F-statistic	0.791791	Prob. F(1,26)	0.3817
Obs*R-squared	0.827498	Prob. Chi-Square(1)	0.3630

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Sample (adjusted): 1984 2011
Included observations: 28 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.074435	0.035575	2.092342	0.0463
RESID^2(-1)	0.171823	0.193097	0.889827	0.3817

R-squared	0.029554	Mean dependent var	0.089846
Adjusted R-squared	-0.007771	S.D. dependent var	0.163799
S.E. of regression	0.164434	Akaike info criterion	-0.703863
Sum squared resid	0.703004	Schwarz criterion	-0.608706
Log likelihood	11.85409	Hannan-Quinn criter.	-0.674773
F-statistic	0.791791	Durbin-Watson stat	1.922800
Prob(F-statistic)	0.381719		

Appendix 14: ARCH-test for residuals hypothesis 6

Soft drink price elasticitiy table as found in Schroeter et al. (2008). Journal of Health Economics 27: 45-68

Goods	Diet Pepsi	Diet Coke	Diet 7-Up	Diet Sprite	Diet Pepper	Diet Private Label	Diet All-Other	Regular 7-Up	Regular Coke	Red. Dr. Pepper	Reg. Mt. Dew	Reg. Pepsi	Reg. RC Cola	Reg. Sprite	Reg. Private label	Reg. All Other
Diet Pepsi	-3,20	0,62	0,13	0,23	0,14	0,10	-1,05	0,32	1,42	0,51	0,19	-1,63	0,34	0,60	0,13	0,09
Diet Coke	0,43	-2,88	0,04	0,12	0,11	-0,02	-1,44	0,24	0,31	0,16	-0,04	1,60	0,55	0,11	0,61	-0,67
Diet 7-Up	0,60	0,27	-1,13	-0,08	-0,11	-0,05	0,01	-0,17	0,73	-0,34	0,09	-0,04	-0,58	-0,01	-0,17	0,25
Diet Sprite	1,75	1,40	-0,13	-1,84	-0,20	-0,66	4,25	-0,62	-0,60	-0,58	-1,77	-0,18	-0,31	-1,45	0,22	-0,23
Diet Dr. Pepper	1,20	1,39	-0,21	-0,23	-1,46	0,10	0,77	-0,35	1,55	-1,41	-0,59	-0,34	-0,82	-0,49	-1,52	-0,91
Diet Private Label	1,04	-0,26	-0,11	-0,83	0,12	-2,29	2,50	-0,28	1,85	1,14	-1,39	-0,95	-0,34	-1,07	1,79	-1,39
Diet All-Other	-0,21	-0,47	0,00	0,12	0,02	0,05	-2,89	0,32	0,95	0,14	-0,12	0,78	-0,23	0,24	0,26	0,15
Regular 7-Up	0,92	1,03	-0,11	-0,23	-0,11	-0,08	4,25	-1,95	-1,52	-0,70	0,82	-2,02	0,20	-0,30	-0,78	-0,20
Regular Coke	0,74	0,20	0,08	-0,04	0,10	0,10	2,27	-0,30	-5,60	0,31	0,58	0,45	0,13	-0,31	0,01	0,05
Reg. Dr. Pepper	1,68	0,82	-0,24	-0,24	-0,52	0,38	2,23	-0,78	1,99	4,56	-1,13	0,36	0,76	-0,33	-1,56	0,81
Reg. Mt. Dew	0,76	-0,27	0,08	-0,95	-0,28	-0,60	-2,44	1,18	4,49	-1,46	-7,66	5,82	0,54	-2,01	1,74	-0,12
Reg. Pepsi	-0,95	1,35	-0,01	-0,02	-0,02	-0,06	2,03	-0,42	0,49	0,05	0,82	-4,32	0,14	0,24	-0,67	0,18
Reg. RC Cola	2,55	6,12	-0,95	-0,30	-0,71	-0,26	-7,95	0,54	1,93	1,75	0,99	1,88	-11,63	0,25	-0,53	5,61
Reg. Sprite	1,95	0,47	-0,02	-0,63	-0,19	-0,38	3,52	-0,38	-1,96	-0,36	-1,63	1,34	0,10	-2,59	-0,13	-0,69
Reg. Private Label	0,17	1,45	-0,08	0,04	-0,31	0,31	1,80	-0,50	-0,02	-0,87	0,72	-2,05	-0,13	-0,07	-2,90	0,62
Reg. All-Other	0,07	-0,60	0,03	-0,02	0,07	-0,09	0,43	-0,04	0,10	0,14	-0,01	0,21	0,44	-0,11	0,25	-1,72

Source: Dhar et al. (2003)

Appendix 15: Soft Drink Price Elasticity table as presented by Schroeter et al (2008).