An Empirical Analysis of Soft Drink Addiction

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Abstract
In this paper I use the theory of rational addiction to empirically analyse if soft drinks are subject to rational addiction. I use aggregate time series data from Sweden over the period 1980 to 2006. First I use the same approach as the founders of the rational addiction theory used in their empirical analysis of rational addiction of cigarette consumption. Afterwards I do a similar regression but with different instrumental variables. I also make regressions with the equation in first difference to correct for trends over time. The results show that soft drink consumption do not fit the rational addiction model.
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1. Introduction

In this paper I test whether the consumption of soft drinks is subject to rational addiction based on aggregate data from Swedish consumption, prices and income during the time period 1980 to 2006.

In modern Swedish society people consume on average approximately 90 litres of soft drinks each year (Agriculture, 2009). Although this gives great pleasure in the moment of consumption, high consumption might be accompanied with health consequences in the future. Common consequences of this high empty calorie intake are overweight and obesity (Vartanian et al., 2007). These are the main growing causes for deceases like Type-2 Diabetes, Cardiovascular-deease, high blood pressure and high cholesterol levels. These illnesses may in turn lead to an abbreviated lifetime (Koning et al., 2012). Roughly 30,000 – 50,000 children in Sweden today are in the risk zone of a premature death due to diabetes, cancer or coronary thrombosis (Marcus, 2006). Even though these health issues are common knowledge to most, the consumption of soft drinks has increased ever since the 1960’s (see figure 1). Is there an explanation to why people drink more and more sugar intense soft drinks even though it is harmful to our health? Sugar is known to be a good that may cause addiction. This is not only due to its good taste but also due to the fact that sugar consumption leads to release of dopamine. Where the latter can also be found in addictive drugs (Avena et al., 2008).

One way of modelling addiction is that addicts are entirely myopic meaning that they are not foresighted and do not regard the future utility when making choices about today’s consumption. Addicts may also be considered habit forming, meaning that addicted individuals are affected by past consumption when making decisions about today’s consumption (Pollak, 1970). Modelling addiction may also be extended with Becker and Murphy’s theory of rational addiction where addicts make intertemporal choices and take the future utility into account when making their choices in the present (Becker & Murphy, 1988). This theory has met some criticism (Akerlof, 1991; Winston 1980) but has also been acknowledged and developed (Gruber & Koszegi, 2001). The rational addiction theory has been tested empirically for many
addictive products e.g. cigarettes (Becker et al., 1994), cocaine (Chaloupka et al., 1999), opium (Liu et al., 1999), alcohol (Baltagi & Griffin, 2002) and milk (Auld & Grootendorst, 2004) and the studies have shown evidence of these products being subjected to rational addiction.
2. Theoretical Approach

In this section I provide the theory background of intertemporal choices leading up to the basic theory of rational addiction and some extensions made to develop ways of modelling addiction.

2.1 Intertemporal choices
When choices made today affect the individuals in future periods, individuals are said to make intertemporal choices. These choices are often trade offs between utility gains in the present and utility losses in the future or vice versa. To calculate present losses or gains and compare them to losses or gains in the future to be able to make a rational choice, the standard model often used is an exponential discount model (Berns et al., 2007).

2.2 Habit formation
There are also some factors that restrict and steer the choices made by individuals. Robert Pollak (1970) writes about the importance of distinguishing short run from long run demand functions and sees three main reasons to why it is so. First, the consumers are locked into contracts of payments. These can be payments for rent or mobile phone contracts. It prevents the consumers to make changes when prices change. Only when the contracts have ended can the consumers act according to their current preferences. Second, consumers might not have perfect information and be aware of all the consumption options there are. If the consumers are to find better options outside their current experience of consumption, they may have to spend time and effort to find better alternatives. Third, the last explanation to why long run and short run demand may differ is because goods can be “habit forming”, that means; the instantaneous utility of consumption depends on past consumption. The more the addicted individuals have consumed in the past, the more addicted they will be and therefore the higher the marginal utility of consumption today will be. This means that a change in income or prices that change consumption will also in turn change the tastes and preferences for that good and therefore change consumption even further, both now and in the future. Instantaneous utility of consumption today when
individuals are subject to habit formation is often modelled with present consumption and past consumption (Pollak, 1970).

2.3 Rational addiction
The habit formation theory was applied to addictive behaviour in the late 80’s by Becker and Murphy when they presented a model that describes how individuals who are addicted to a good actually make rational decisions in terms of also taking the future utility into account (Becker & Murphy, 1988). Being addicted might seem like the opposite of making a rational choice but the rational addiction model assume that individuals may anticipate the future and take the discounted future utility into account when making their choices today. The larger the past consumption has been, the higher the current marginal utility of consumption will be. Also as the current consumption increases, future utility losses will be higher. This will lead up to a trade off when the individuals choose the utility maximizing level of consumption today. Becker and Murphy’s contribution shows a hypothesis that addicted individuals may be modelled as rational in terms of forward-looking behaviour (Becker & Murphy, 1988). This theory has been used to explain the behaviour of addicts of e.g. cigarettes (Becker et al., 1994), alcohol (Baltagi & Griffin, 2002) and drugs (Chaloupka et al., 1999) (Liu et al., 1999).

The rational addiction model in terms of soft drinks addicts can be motivated as follows; when the body has adapted to high sugar intake, withdrawal means that the individuals will feel bad because of the cravings. This gives soft drink consumption a higher marginal utility in the present; it removes the cravings as well as gives the pleasurable feeling the individuals are looking for. The addicts also take the future health issues into account where the risk of obesity and related illnesses increase with higher consumption and they make a trade off between utility gains in the present and utility losses in the future to exploit the situation for maximal pleasure, happiness and welfare over their lifetime. So for addicts with their current preferences, continuing taking the substance is the optimal choice because they would be unhappier if they were prevented from consuming the good.
Criticism has been aimed at Becker and Murphy’s rational addiction theory of not being consistent with empirical evidence because the addicts portrayed in their theory can be seen as “happy addicts”, being addicts without regret (Winston, 1980). The rational addict model is also criticised because people are becoming addicted “knowingly” and therefore “intentionally” (Akerlof, 1991).

2.4 Self-control problems
The traditional approach to rational addiction that is mentioned above implies that people are time consistent. This means that individuals who have made a choice in the present would stick to it and have made the same choice in the future when they look back on their decision. This is not always the case though; in a study by Thaler (1981) this is tested in a survey where people were first asked to choose between one apple today or two apples tomorrow, where most chose an apple today. Then the subjects were asked to choose between one apple in a year or two apples in one year and a day, where most chose two apples. But one year into the future, time inconsistency would occur if they had the opportunity to reconsider, most people would then change their decision and take one apple that day as this decision is similar to the first one. This is a self-control problem that originates from people being inconsistent over time. People will put too little emphasis on future utility and therefore do not make rational choices that are sustainable in the long run. This can lead to the case where people have made a choice and do not see the full value of the utility losses in the future and later on regret their decision (Thaler, 1981). If people are time inconsistent they might need help in their decision making to make rational choices that are sustainable in the long run. In these cases a sin tax may be motivated to help people make the most rational choices (O'Donoghue & Rabin, 2003).
3. Data

In this section I provide the data I use in the empirical application. I provide information about where the data is collected and comment on current trends that can be seen in the raw data.

All data is sorted in time series and collected from either Statistics Sweden or from the Swedish Board of Agriculture in April 2015. The time series stretch from 1980 to 2006. All variables are shown in table 1.

Table 1 – Variable statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Measurement</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. Deviance</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumption</td>
<td>Litres/Cap</td>
<td>27</td>
<td>58,9</td>
<td>22.566</td>
<td>28,4</td>
<td>94,5</td>
</tr>
<tr>
<td>Price</td>
<td>Real price Index</td>
<td>27</td>
<td>0,906</td>
<td>0,0898</td>
<td>0,781</td>
<td>1,042</td>
</tr>
<tr>
<td>Income</td>
<td>Real BNP/Cap</td>
<td>27</td>
<td>144392</td>
<td>32578</td>
<td>109455</td>
<td>234900</td>
</tr>
</tbody>
</table>

The soft drinks consumption is measured in amount of litres consumed on average per capita each year. It is collected from the Swedish Board of Agriculture. The average consumption of soft drinks has increased from 1980 to 2006 (see figure 1). Starting in 1980 where the average Swedish consumer drank about 28 litres of soft drinks each year. Up until 2006 where the consumption exceeds almost 95 litres per capita each year. Income is represented by aggregate income per capita, shown in Swedish Krona. It is collected as real GDP per capita from Statistics Sweden. Real price index of soft drinks is collected from the Swedish Board of Agriculture. The real price index starts with a price level of 1 in 1980 and has since then decreased over time until 2006 to the lowest price index of 0.781 (see table 1). The real price of soft drinks has decreased about 22% during this time period (see figure 2). Time periods are denoted by t. Each time period is one year. Lagged or leading variables are denoted with t-x and t+x respectively, where x represents number of lags or leads.
Figure 1

Consumption of soft drinks measured in litres consumed on average per person each year from 1980 to 2006.

Figure 2

Real price index of soft drinks varying over years 1980 to 2006.
4. Method

In this section I provide the basic model used in the empirical application. I first briefly show how the equation is derived. Thereafter I present the null hypothesis that is tested and the methods used for the regressions. Three different regressions are made. First an OLS regression, second a 2SLS regression made according to Becker, Grossman and Murphy’s approach to solve for an endogeneity problem (Becker et al., 1994), third a 2SLS based on different instruments. The models are tested for unit root with Dickey-Fuller tests. Models where unit root is detected are corrected and tested again with the equation in first difference.

4.1 The Model

Below I present a summary of the rational addiction model used by Becker, Grossman and Murphy (Becker et al., 1994).

In the classic rational addiction model as stated by Becker, Grossman and Murphy (1994) the instantaneous utility is not time separable in the consumption of the addictive good. So when looking at the instantaneous utility in time period t, the utility is derived from both the present and past consumption (see equation 1).

\[
U_t = U(Y_t, C_t, C_{t-1}, e_t)
\]

where, \(C_t\) is the amount of soft drinks consumed in period t. \(C_{t-1}\) is the amount of soft drinks consumed in the previous period. \(Y_t\) is the consumption of another composite good in period t, and \(e_t\) reflects the impact of unmeasured life-cycle variables on the instantaneous utility in period t.

\(Y\) is the numeraire, the price of which is normalized to one. Interest rate is equal to the individual’s rate of time preference and the price of soft drinks in period t is denoted \(P_t\). Then a representative individual’s decision-problem will look like:

\[
\max_{C_t} \sum_{t=1}^{\infty} \beta^{t-1} U(C_t, C_{t-1}, Y_t, e_t)
\]
subject to the budget constraint:

$$\sum_{t=1}^{\infty} \beta^{t-1} (Y_t + P_tC_t) = A^0$$

where $\beta = 1/(1+r)$ denotes the discount factor where $r$ is the discount rate. $A^0$ is the present value of wealth.

The first order conditions for utility maximization are:

(3) \[ U_1(C_t, C_{t-1}, Y_t, e_t) + \beta U_2(C_{t+1}, C_t, Y_{t+1}, e_{t+1}) = \lambda P_t \]

(4) \[ U_3(C_t, C_{t-1}, Y_t, e_t) = \lambda \]

$U_1$ is maximization of present utility with respect to the first variable; $C_t$. $U_2$ is maximization of future utility with respect to the second variable; $C_t$. $U_3$ is utility maximization with respect to the third variable; $Y_t$.

Equation (3) means the condition that the marginal utility of soft drink consumption in the present $U_1$ plus the discounted marginal effect on the next period’s utility $U_2$ equals the current price level of soft drinks times the marginal utility of wealth.

Equation (4) is the condition that the marginal utility of the numeraire equals the marginal utility of wealth, $\lambda$.

If the good in question is harmful in the next period, as it is assumed when high soft drink consumption may lead to health problems in the future, $U_2$ will be negative.

Becker et al. (1994) solved the first order conditions for $C_t$ while assuming a quadratic utility function. Below I present their solution; equation (5):

(5) \[ C_t = \theta_1 C_{t-1} + \beta \theta_2 C_{t+1} + \theta_3 P_t + \theta_4 e_t + \theta_5 e_{t+1} \]
Equation (5) is the basic model that will be tested. The crucial part is to estimate whether $\theta_2$ is significantly different from zero. If $\theta_2$ is significant with a positive sign, the individual is forward looking and takes into consideration that consumption in period $t$ will affect utility in period $t+1$. If $\theta_2$ would not be significantly different from zero, the individual would disregard the second part on the left hand side of equation (4): $\beta U_2(C_{t+1}, C_t, Y_{t+1}, e_{t+1})$, and not take the future into account when making choices in the present. $\theta_1$ will represent the effect of habit formation from past consumption. Therefore, if $\theta_1$ and $\theta_2$ are significantly different from zero with positive signs, the individual is considered to be rationally addicted to the good because the past consumption affects present consumption and the individual also recognizes that the future utility is affected by the present consumption. The sign and magnitude of $\theta_1$ and $\theta_2$ explain the effect of present soft drink consumption that comes from habit formation respective effects on the rational anticipation of future consequences.

To capture the effect on consumption of income differences I use the same method as Becker, Grossman and Murphy (1994) did and include income ($I$). This gives in equation (6).

\[
C_t = \theta_0 + \theta_1 C_{t-1} + \beta \theta_2 C_{t+1} + \theta_3 P_t + \theta_4 I_t + \varepsilon_t
\]

where $\varepsilon_t$ denote the error term.

The main interest of this study is to find out whether individuals are forward-looking and hence not entirely myopic. Therefore $\theta_2$ will be the coefficient of most concern, which is shown in the null hypothesis below.

**4.2 First regression - OLS**

Equation (6) will be estimated by using an Ordinary Least Square regression. The null hypothesis and alternative are written as follows:

\[
H_0: \theta_2 = 0 \quad H_A: \theta_2 > 0
\]
The null hypothesis means that the coefficient of $C_{t+1}$ is zero and therefore $C_{t+1}$ has no effect on $C_t$, then future utility will not be regarded when making choices today. The alternative hypothesis means that effects on future utility will be regarded when making choices today, which means that the individual is not entirely myopic.

4.3 Second regression – 2SLS according to Becker and Murphy

Becker, Grossman and Murphy (1994) identified a likely endogeneity problem where $C_{t-1}$ and $C_{t+1}$ correlate with the error term in equation (6). Using instrumental variables for past and future consumption can correct for this. The approach used by Becker, Grossman and Murphy (1994) is to use the prices in the respective time period as instruments; $P_{t-1}$ as instrument for $C_{t-1}$ and $P_{t+1}$ for $C_{t+1}$. Because price is assumed to explain the consumption.

So the next regression is made using Two Stage Least Square to correct for the endogeneity. In this regression I make estimates in two steps. In the first stage, I estimate reduced form equations for $C_{t-1}$ and $C_{t+1}$ as functions of the two instruments $P_{t-1}$ and $P_{t+1}$ as well as of $P_t$ and $I_t$. In the second stage, I replace $C_{t-1}$ and $C_{t+1}$ in equation (6) with the predictions from the first stage. Predictions are denoted with ($\hat{\cdot}$).

First stage:

\[
\begin{align*}
C_{t-1} &= \alpha_0 + \alpha_1 P_{t-1} + \alpha_2 P_{t+1} + \alpha_3 P_t + \alpha_4 I_t + \mu_{t-1} \quad \Rightarrow \quad \hat{C}_{t-1} \\
C_{t+1} &= \alpha_0 + \alpha_1 P_{t-1} + \alpha_2 P_{t+1} + \alpha_3 P_t + \alpha_4 I_t + \mu_{t+1} \quad \Rightarrow \quad \hat{C}_{t+1} 
\end{align*}
\]

Second stage:

\[
C_i = \theta_0 + \theta_1 \hat{C}_{t-1} + \beta \theta_2 \hat{C}_{t+1} + \theta_3 P_t + \theta_4 I_t + \epsilon_i
\]
4.4 Third regression – 2SLS with different instruments

$P_{t-1}$ and $P_{t+1}$ will later be shown to not be significant instruments and therefore I do a third regression using other exogenous variables as instruments. This regression is made in the exact same way as the second regression with the slight difference of using other variables as instruments. Instead of prices in respective time periods the instruments used are $C_{t-2}$ and $P_{t-2}$. This is done because I want to find instruments that correlate significantly with $C_{t-1}$ and $C_{t+1}$ and the data suggests that these variables fit best.

First stage:

\[
C_{t-1} = \alpha_0 + \alpha_1 C_{t-2} + \alpha_2 P_{t-2} + \alpha_3 P_t + \alpha_4 I_t + \mu_{t-1} \Rightarrow \hat{C}_{t-1}
\]

\[
C_{t+1} = \alpha_0 + \alpha_1 C_{t-2} + \alpha_2 P_{t-2} + \alpha_3 P_t + \alpha_4 I_t + \mu_{t+1} \Rightarrow \hat{C}_{t+1}
\]

Second stage:

\[
C_t = \theta_0 + \theta_1 \hat{C}_{t-1} + \beta \theta_2 \hat{C}_{t+1} + \theta_3 P_t + \theta_4 I_t + \epsilon_t
\]

To find out whether there is a trend over time in the data which can in turn lead to unreliable results, I test all variables for unit root with Dickey-Fuller tests where the null hypothesis states that the variable has a unit root and therefore is non-stationary. If the null hypothesis cannot be rejected I correct for this by doing the same regressions with all variables in first difference to correct for the non-stationary.

Equation (6) with all variables in first difference gives equation (7):

\[
\Delta C_t = \theta_1 \Delta C_{t-1} + \beta \theta_2 \Delta C_{t+1} + \theta_3 \Delta P_t + \theta_4 \Delta I_t + \Delta \epsilon_t
\]
5. Results

In this section I provide a correlation table and the estimates from the OLS regression and the 2SLS regressions. The section is divided into three parts: first correlation, thereafter all regressions in the order stated in the method section and finally a summary of the results.

5.1 Correlation

To first see a view over how the variables correlate to each other I present a correlation table of all the variables (see table 2) that are used in the regressions.

<table>
<thead>
<tr>
<th>Correlation</th>
<th>$C_t$</th>
<th>$P_t$</th>
<th>$I_t$</th>
<th>$C_{t-1}$</th>
<th>$C_{t+1}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_t$</td>
<td>1</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>$P_t$</td>
<td>-0.822</td>
<td>1</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>$I_t$</td>
<td>-0.656</td>
<td>0.628</td>
<td>1</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>$C_{t-1}$</td>
<td>0.985</td>
<td>-0.816</td>
<td>-0.630</td>
<td>1</td>
<td>*</td>
</tr>
<tr>
<td>$C_{t+1}$</td>
<td>0.985</td>
<td>-0.841</td>
<td>-0.674</td>
<td>0.964</td>
<td>1</td>
</tr>
</tbody>
</table>

In the correlation table (see table 2) both consumption in the past $C_{t-1}$ and the future $C_{t+1}$ strongly correlate to consumption in the present $C_t$. The price also correlate strongly with present consumption with a value of -0.822. The income variable has the lowest correlation with a value of -0.656. The income has therefore not that strong relationship with the consumption of soft drinks.
5.2 Regression results

Regression (1) - OLS regression:

Table 3 – Results from the OLS regression

<table>
<thead>
<tr>
<th>C_t (dependent)</th>
<th>Coefficient</th>
<th>St. error</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C_{t-1}</td>
<td>0.503</td>
<td>0.092</td>
<td>5.46</td>
</tr>
<tr>
<td>C_{t+1}</td>
<td>0.522</td>
<td>0.102</td>
<td>5.11</td>
</tr>
<tr>
<td>P_t</td>
<td>8.041</td>
<td>11.224</td>
<td>0.72</td>
</tr>
<tr>
<td>I_t</td>
<td>-6.18*e-06</td>
<td>0.0000258</td>
<td>-0.24</td>
</tr>
</tbody>
</table>

F-test is significant at 1% level. R^2 equals 0.988. Intercept is not shown.

In this regression the null hypothesis is rejected where the coefficient $\theta_2$ is significantly differentiated from zero. This suggests that the individual is not entirely myopic and therefore is forward looking. Coefficients of price and income are not significant in the OLS regression and therefore the coefficients are problematic to interpret. The coefficients of $C_{t-1}$ and $C_{t+1}$ are significantly estimated with t-values over 5 (see table 3). Both coefficients have positive signs, which are in line with the rational addiction theory along with habit formation and forward-looking consumption choices. Compared to Becker, Grossman and Murphy’s study (1994) of consumption of cigarettes, the coefficients of $C_{t-1}$ and $C_{t+1}$ are of similar sign and greater magnitude.
Regression (2) - 2SLS regression where $P_{t-1}$ and $P_{t+1}$ are instruments in the first stage:

First stage:

Table 4 – Results from the first stage regression

<table>
<thead>
<tr>
<th>$C_{t-1}$ (endogenous)</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{t-1}$ (exogenous)</td>
<td>-1.77</td>
</tr>
<tr>
<td>$P_{t+1}$ (exogenous)</td>
<td>-1.10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$C_{t+1}$ (endogenous)</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{t-1}$ (exogenous)</td>
<td>-2.99</td>
</tr>
<tr>
<td>$P_{t+1}$ (exogenous)</td>
<td>-0.95</td>
</tr>
</tbody>
</table>

$P_t$ and $I_t$ are also used as explanatory variables in the first stage regressions but their effects are not significant.

In this first stage estimation only the effect of $P_{t-1}$ is significant in the equation for $C_{t+1}$ at a 1% significance level (see table 4). $P_{t+1}$ is significant at a 10% significance level in the equation for $C_{t-1}$. The effects of the other explanatory variables are not significantly different from zero. This is an indication that the estimated endogenous variables may not be fully trusted in the second stage.

Second stage:

Table 5 – Results from the second stage regression

<table>
<thead>
<tr>
<th>$C_t$ (dependent)</th>
<th>Coefficient</th>
<th>St. error</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_{t-1}$</td>
<td>0.611</td>
<td>0.341</td>
<td>1.79</td>
</tr>
<tr>
<td>$C_{t+1}$</td>
<td>0.423</td>
<td>0.232</td>
<td>1.61</td>
</tr>
<tr>
<td>$P_t$</td>
<td>9.880</td>
<td>22.542</td>
<td>0.44</td>
</tr>
<tr>
<td>$I_t$</td>
<td>-8.38e-06</td>
<td>0.0000271</td>
<td>-0.31</td>
</tr>
</tbody>
</table>

The endogenous variables $C_{t-1}$ and $C_{t+1}$ are instrumented by $P_{t-1}$ respectively $P_{t+1}$. $R^2$ equals 0.987. Intercept is not shown.
This regression show estimated coefficients for $\hat{C}_{t-1}$ and $\hat{C}_{t+1}$ of 0.611 respective 0.423 (see table 5). Both coefficients are positive but the estimates are not significant even on a 10% level so the null hypothesis may not be rejected. Since the first stage regressions did not work well, one should not rely on the results in the second stage.

Regression (3) – 2SLS regression where $C_{t-2}$ and $P_{t-2}$ are instruments in the first stage:

First stage:

Table 6 – Results from the first stage regression

<table>
<thead>
<tr>
<th>$\hat{C}_{t-1}$ (endogenous)</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_{t-2}$ (exogenous)</td>
<td>-13.55</td>
</tr>
<tr>
<td>$P_{t-2}$ (exogenous)</td>
<td>-2.94</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$\hat{C}_{t+1}$ (endogenous)</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_{t-2}$ (exogenous)</td>
<td>5.45</td>
</tr>
<tr>
<td>$P_{t-2}$ (exogenous)</td>
<td>-4.03</td>
</tr>
</tbody>
</table>

$P_t$ and $I_t$ are also used as explanatory variables in the first stage regressions but their effects are not significant.

In this first stage estimation (see table 6) both $C_{t-2}$ and $P_{t-2}$ are significant instrumental variables in the equations of both $\hat{C}_{t-1}$ and $\hat{C}_{t+1}$. Both $C_{t-2}$ and $P_{t-2}$ have significant effects at 1% significance level.

Second stage:

Table 7 – Results from the second stage regression

<table>
<thead>
<tr>
<th>$C_t$ (dependent)</th>
<th>Coefficient</th>
<th>St. error</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\hat{C}_{t-1}$</td>
<td><strong>0.442</strong></td>
<td>0.117</td>
<td><strong>3.76</strong></td>
</tr>
<tr>
<td>$\hat{C}_{t+1}$</td>
<td><strong>0.596</strong></td>
<td>0.140</td>
<td><strong>4.24</strong></td>
</tr>
<tr>
<td>$P_t$</td>
<td>9.720</td>
<td>11.5517</td>
<td>0.84</td>
</tr>
<tr>
<td>$I_t$</td>
<td>1.37e-06</td>
<td>0.0000272</td>
<td>0.05</td>
</tr>
</tbody>
</table>

The endogenous variables $C_{t-1}$ and $C_{t+1}$ are instrumented by $C_{t-2}$ respectively $P_{t-2}$.

R$^2$ equals 0.989. Intercept is not shown.
In this final stage of the 2SLS regression (see table 7) the null hypothesis of \( \theta_2 \) being zero may be rejected at a 1% level, this is also the case for \( \theta_1 \). These estimates are an indication that people are not entirely myopic. The sign and magnitude of the coefficients of \( \hat{C}_{t-1} \) and \( \hat{C}_{t+1} \) are of similar sign and greater magnitude as for cigarettes (Becker et al., 1994).

A possible reason why regression (3) shows significant estimates compared to the previous regression (2) is due to that the instruments do not correlate too much with each other. Correlation between \( P_{t-1} \) and \( P_{t+1} \) is 0.98, while correlation between \( C_{t-2} \) and \( P_{t-2} \) is 0.81. Because of this, \( C_{t-2} \) and \( P_{t-2} \) are better instruments in this data.

The high R\(^2\) value seen in all regressions is a warning sign that the model has a unit root. Augmented Dickey-Fuller tests with two lags and the null hypothesis that the model has a unit root were made on all time series to find out if they are non-stationary and therefore may give unreliable results. The null hypothesis could never be rejected in any of the tests, which implies that all time series have a unit root. To correct for this, regressions with all variables in first difference are made.

Regression (4) - OLS regression in first difference:

<table>
<thead>
<tr>
<th>( \Delta C_t ) (dependent)</th>
<th>Coefficient</th>
<th>St. error</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \Delta C_{t-1} )</td>
<td>0.384</td>
<td>0.210</td>
<td>1.82</td>
</tr>
<tr>
<td>( \Delta C_{t+1} )</td>
<td>0.259</td>
<td>0.199</td>
<td>1.30</td>
</tr>
<tr>
<td>( \Delta P_t )</td>
<td>10.550</td>
<td>30.198</td>
<td>0.35</td>
</tr>
<tr>
<td>( \Delta I_t )</td>
<td>-0.0000515</td>
<td>0.0001208</td>
<td>-0.43</td>
</tr>
</tbody>
</table>

F-test is significant at 10% level. R\(^2\) equals 0.31. Constant is supressed.

In this regression the null hypothesis that the coefficient of \( \Delta C_{t+1} \) is zero may not be rejected. The t-value is 1.30 for \( \Delta C_{t+1} \), which implies that people being entirely myopic may not be rejected. The regression was made with the equation in first difference and therefore has no constant (see equation 7).
Regressions with the 2SLS method with the equation in first difference are also made but none of the instruments are significant and therefore the results in the second stage are not reliable. The coefficients and t-values from these tests, named regression (5) respective regression (6), are shown in table 9 below, but they may not be trusted as the instruments are insignificant. Regression (5) and (6) used the same instruments as regression (2) respective (3).

5.3 Summary of results

Table 9 – Summary of results

<table>
<thead>
<tr>
<th>Regression</th>
<th>$C_{t+1}/\bar{C}_{t+1}$ coef. ($\theta_2$)</th>
<th>t-value</th>
<th>Endogeneity problem</th>
<th>Unit root</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) OLS</td>
<td>0.522</td>
<td>5.11</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>(2) 2SLS (P$<em>{t-1}$, P$</em>{t+1}$)</td>
<td>0.423</td>
<td>1.61</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>(3) 2SLS (C$<em>{t-2}$, P$</em>{t-2}$)</td>
<td>0.596</td>
<td>4.24</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>(4) OLS first diff.</td>
<td>0.259</td>
<td>1.30</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>(5) 2SLS (ΔP$<em>{t-1}$, ΔP$</em>{t+1}$)</td>
<td>-0.245</td>
<td>-0.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6) 2SLS (ΔC$<em>{t-2}$, ΔP$</em>{t-2}$)</td>
<td>0.852</td>
<td>1.33</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Regression (1) and (3) may reject the null hypothesis (see table 9), but regression (1) face problems of endogeneity and unit root, and regression (3) has a unit root. Therefore the results are not reliable. Regression (5) and (6) are corrected for endogeneity and unit root but may not reject the null hypothesis of $\theta_2$ being zero.
6. Conclusion

The results in this empirical analysis do not reject the null hypothesis that individuals consuming soft drinks are entirely myopic. The use of unconventional instruments in the 2SLS regression (3) compared to the original method in regression (2) seemed to be able to reject the null hypothesis of entirely myopic individuals when the model is estimated in level form. But after the models were corrected for endogeneity and unit root they did not show significant effects of future consumption, which means that people do not regard the future utility when making choices. Comparing this result to a previous study by Liu and Lopez (2012) that also empirically analyse if soft drinks are rationally addictive, showed not only the opposite, but showed that soft drinks are strongly rational addictive. Liu and Lopez (2012) study was made with the same method but instead of aggregate time series data they used panel data over 46 cities in the US (Liu & Lopez, 2012).

Even though my data do not fit the rational addiction model, I do not completely reject that soft drink consumption may not be modelled as rational addictive. The problem may be in the use of aggregate data where many other studies have used panel data, including Becker, Grossman and Murphy’s empirical analysis (Becker et al., 1994). The reason why aggregate data may not be the most adequate data is because the rational addiction equation (see equation 5) is derived from an individual’s utility maximization problem. To estimate the model on aggregate data it is assumed that all individuals are similar, while this might not be the case in reality where we rather can assume heterogeneous consumers with different preferences. The problem with modelling rational addiction when using aggregate data has been found in other studies also. In a study by Bask and Melkersson (2004) of analysing cigarettes (which have earlier been shown to be rational addictive (Becker et al., 1994)) when using aggregate data from Sweden, cigarettes consumers were not found to be forward-looking (Bask & Melkersson, 2004).

For future analyses regarding soft drink addiction I would suggest to use panel data on individual level. Then probably the conclusion can be drawn that people are not
entirely myopic but also forward looking when making decisions. With panel data on individual level it will also be possible to analyse if people make long run rational choices or if they are time inconsistent and therefore do not make rational choices that are sustainable in the long run. Because if people are time inconsistent they may have self-control problems and regret their previous decisions. Therefore they might need help with their decision-making. This problem can be seen in products like cigarettes and alcohol, where the state has tried to help people decrease their consumption with a sin tax. A sin tax on soft drinks could be motivated if it was shown that people have self-control problems in terms of being time inconsistent. It would also be interesting to analyse consumption of other goods that are high in sugar e.g. candy.
7. Bibliography


