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# An Empirical Analysis of Alcohol Addiction in 21 Century U.S.

By

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Abstract

This paper is a replication of *An Empirical Analysis of Alcohol Addiction: Results From The Monitoring The Future Panels* with the same theoretic and empirical frameworks but different and new dataset. The aims of this paper are to use rational addictive model to examine alcohol consumption behavior. Specifically, with the interdependency of past, current and future consumption of addictive goods like alcohol, rational addictive model can explain that the consumption of addictive goods is actually addictive. The new data comes from National Longitudinal Survey of Youth, 1979 and the age of the observants comes from different level, which will have more comprehensive results. By the end of the study, although the results are not statistically significant, they still show that alcohol consumption is actually an addictive behavior in a sense that past or future consumption of alcohol will cause the current consumption of alcohol to rise. This positive future or past consumption effect is in line with rational addiction theory and inconsistent with myopic addiction. The long run and short run price elasticity is negative and the ratio is about 1.43, which is less than the comparable ratio of 1.60 from the replicating paper.

## Introduction & Literature Reviews

Alcohol is a substance that most of the people in the world have at least some knowledge of. Alcohol exists everywhere in our daily lives, from disinfection production that are used in medical sectors to alcoholic beverages that are consumed by human beings. One can conclude that we are all surrounded by alcohol.

However, the effects of alcohol are a double-edged sord: people can make good use of it while at the same time people can be addicted to it and results in devastating health issues. According to National Institute on Alcohol Abuse and Alcoholism (NIAAA), drinking alcohol can cause several effects on human body organs, including brain, heart, liver, pancreas, immune system, and can possibly lead to several types of cancer. Among those bad effects on human body, the effect on brain is the most common type of effects that we encounter in our daily lives. The name of this effect is called 'blackout', which means gaps in a person's memory for events that occurred while they were intoxicated. These gaps happen when a person drinks enough alcohol to temporarily block the transfer of memories from short-term to long-term storage—known as memory consolidation—in a brain area called the hippocampus. There are two types of blackouts; they are defined by the severity of the memory impairment. The most common type is called a "fragmentary blackout" and is characterized by spotty memories for events, with "islands" of memories separated by missing periods of time in between. This type is sometimes referred to as a "grayout" or a "brownout." The second type is called complete amnesia, often spanning hours, is known as an "en bloc" blackout. With this severe form of blackout, memories of events do not form and typically cannot be recovered. It is as if the events simply never occurred. Additionally, according to several researches on college students and other young adults from NIAAA, researchers discover that the frequency of blackouts predicts other alcohol related consequences such as missing school or work, having a lower grade point average, being injured, ending up in the emergency room, getting arrested or experiencing other negative outcomes.

While excessive alcohol misuse is a concern among all age groups, it is even more typical among teenagers and young adults. NIAAA defines this type of excessive alcohol misuse as “binge drinking’, which means consuming 4 or more drinks for female or consuming 5 or more drinks for male within 2 hours. The blood alcohol concentration in bodies can reach 0.08 percent or even higher if an individual is having binge drinking. According to the 2019 National Survey on Drug Use and Health, about 66 million, or about 24 percent of people in the United States ages 12 and older reported binge drinking during the past month.

Excessive alcohol misuse can be lethal. Roughly 95,000 deaths resulted from alcohol misuse in the United States between 2011 and 2015, and almost half (46 percent) were associated with binge drinking. (Esser, Sher, Liu et al, 2020) Addutionally, excessive alcohol misuse can be very costly. Sacks, Gonzales, Bouchery et al. estimated that binge drinking accounted for 77 percent ($191.1 billion) of the $249 billion economic cost of alcohol misuse in 2010. (2015)

Another big issue with consuming alcohol is that mixing alcohol with other foods or substance may cause dangerous side effects, sometimes even result in death. It is very popular to mix energy drinks such as monster to alcoholic beverages among young adults and college students. The purpose of doing that is to boost the flavor or to make alcoholic beverage contain less alcohol. However, according to Centers for Disease Control and Prevention (CDC), when alcohol is mixed with caffeine, the caffeine can mask the depressant effects of alcohol, making drinkers feel more alert than they would otherwise. As a result, individuals may drink more alcohol and become more impaired than they realize, increasing the risk of alcohol-attributable harms.

As I mentioned before, drinking pattern among young adults and college students are more aggressive than adults. These patterns become even more severe when it comes to underage drinking, which is individuals who are under 21, by United States law, drink alcoholic beverages. People ages 12 to 20 drink 4.0 percent of all alcohol consumed in the United States. Although youth drink less often than adults does, when they do drink, they drink more. More than 90 percent of all alcoholic drinks consumed by young people are consumed through binge drinking. (NIAAA) Binge drinking mentioned before becomes common within teenagers such as high school students. According to CDC's Youth Risk Behavior Survey in 2019, among high school students, during the past 30 days, 29% of them drank alcohol; 14% of them had binge drinking; 5% of drivers drove after drinking alcoholic beverages; 17% of them rode with a driver who had been drinking alcohol. The underage drinking patterns also vary by age and gender. According to NIAAA, alcohol use often begins during adolescence and becomes more likely as adolescents age. In 2019, almost 2 out of 100 adolescents ages

12 to 13 reported drinking alcohol in the past month and fewer than 1 in 100 engaged in binge drinking. Among respondents ages 16 to 17, fewer than 1 in 5 reported drinking and about 1 in 10 reported binge drinking. It is important to implement prevention strategies during early adolescence to prevent this escalation. Historically, adolescent boys were more likely to drink and binge drink than girls. Now, that relationship has reversed. Alcohol use has declined more in recent years among adolescent boys than it has in girls. As a result, more adolescent girls report alcohol use and binge drinking than boys. (Chen, Yoon & Faden, 2017) The similar severe drinking pattern among teenagers are also been verified by Grossman, Chaloupka and Sirtalan (1994). They used teenager panel data from The Monitoring the Future Panels and showed that teenagers drink more than adults.

Since the drawbacks of drinking alcohol are overwhelming and devastating, it is reasonable to conduct research on alcohol addictive behavior. Specifically, if we can use economic models to fit the alcohol addictive behavior, we can manipulate the drawbacks of alcohol consumption by government policy such as taxation. Fortunately, many papers have addressed the general addictive behavior and developed a theoretical framework for general addiction. Alcohol addiction has also been tested by previous researchers using the general addiction theoretical framework empirically. Nevertheless, as the world changing rapidly, the drinking patterns among different ages also change rapidly. Whether the previous empirical testing results are still valid or not is under question. Therefore, in this paper, I plan to replicate the paper *An Empirical Analysis of Alcohol Addiction: Results From The Monitoring The Future Panels,* using newer dataset from National Longitudinal Survey of Youth, 1979, and to see if the results still exhibit the same pattern as before.

In 1988, Becker and Murphy developed a theoretical model of addictive behavior which assumes that individuals behave rationally. The paper started with a question: Does drug users care about future, and tried to incorporate rational framework into addictive behavior. Becker and Murphy (1998) successfully developed a theory of rational addiction and claimed that “People get addicted not only to alcohol, cocaine, and cigarettes but also to work, eating, music, television, their standard of living, other people, religion, and many other activities. Therefore, much behavior would be excluded from the rational choice framework if addictions have to be explained in another way. Fortunately, a separate theory is not necessary since rational choice theory can explain a wide variety of addictive behavior.” (1988, p676) This claim inspired me and made me confidence on fitting different addictive substances using this rational addiction model.

One of the main elements of the paper and the models of addictive behavior is that an increase in past consumption of an addictive good (such as cigarettes, alcohol or caffeine) raises the marginal utility of current consumption of the addictive good and therefore raises the current consumption of the addictive good. The important feature of the rational addiction model that distinguishes it from other addiction models is that it treats the addictive behavior as rational behavior. When talking about rational, the rational addiction model asserts that individual in the model will anticipate the expected future consequences of current results. This is in sharp contrast of another addiction model, which is called myopic models of addiction. Previously, before the development of rational addiction model, many researchers were trying to study habitual action or demand function using myopic frameworks. (Pollak, 1970, 1976; Yaari, 1977). The main drawbacks of the myopic framework of modeling addictive behavior are that myopic individuals fails to consider the impact of current consumption on future utility and future consumption when they determine the optimal or utility-maximizing quantity of an addictive good in the present time.

Additionally, Becker and Murphy (1988) provided many empirically testable predictions on addictive goods. These results and predictions include that negative cross price elasticity effects, a long-run price elasticity of demand will exceed the short-run price elasticity of demand and "cold turkey" quit behavior. Among those results and predictions, a fundamental aspect of rational addiction is the negative cross price elasticity effects or intertemporal complementarity of consumption. This effect will cause a result that an increase in past or future consumption of addictive good (caused by reductions in past or future prices) will cause current consumption of addictive good to rise. This key finding from mathematical derivation is also in accordance with reinforcement effect of an addictive good, which is emphasized by many psychologists. (Herrnstein and Prelec,) They suggest that an increase in past consumption of an addictive good raises the marginal benefits of current consumption of an addictive good. Same logic applies to the other side, an increase in future consumption of an addictive good also raises the marginal benefits of current consumption of an addictive good.

After the publish of Becker and Murphy (1988) paper, many researchers had successfully applied the model to different types of addictive goods such as cigarette, alcohol, coffee, milk and other possible addictive goods. Becker, Grossman and Murphy (1994) provided empirical study of cigarette addiction using time series data of state cross sections covering the 50 states of the U.S. and the District of Columbia from 1955 through 1985. Their empirical results showed that the hypothesis of cigarette addiction is true: smoking is actually an addictive behavior in a sense that an increase in past consumption of cigarettes increases the current consumption of cigarettes. Their results also suggested that people are forward looking, which in a sense that an increase in future consumption of cigarettes increases the current consumption of cigarettes. Their long-run price elasticity of demand of approximately -0.75 is almost twice as large as the short-run price elasticity of demand of approximately -0.40. Furthermore, their cross-price effects are also significant. A 10 percent reduction in current price leads to an increase of approximately 1.5 percent in the next period's consumption and approximately 0.6 percent increase in the previous period's consumption. Smoking levels in different years appear to be complements: cigarette consumption in any year is lower when both future and past prices are higher.

Chaloupka (1991) provides further evidence in support of rational model of cigarette addiction using an individual level dataset: the second National Health and Nutrition Examination Survey from 1976 to 1980. The survey contains approximately 28000 people aged from 6 months to 74 years. In Chaloupka's results, everything is similar to Becker, Grossman and Murphy (1994). He proved that smoking is actually an addictive behavior in a sense that an increase in past consumption increases the future consumption. He also found that the long-run price elasticity of -0.45 is larger than the short-run price elasticity of -0.20. The positive and statistically significant future cigarette consumption coefficient in his demand function further suggest that individuals are not myopic, and price increases would reduce demand of smoking. Since they have participants from different education and age group, Chaloupka also found that more educated people are more forward looking than less educated people, and more addicted people are found to respond more to price change, in the long run, than less addicted people.

Keeler, Hu, Barnett and Manning (1993) also provided evidence to support the model of rational addiction. Their data comes from the California Board of Equalization, and it is a time series data from a monthly based per capita consumption from 1980 through 1990 in California. Their works analyzed the effects of prices and taxation on cigarettes (a 25 cent per pack state tax increase in 1989). They found that an increase in past consumption of cigarettes increases the current consumption of cigarettes and an increase in future and past price of cigarettes decreases the current consumption of cigarettes. The short-run price elasticity is from -0.3 to -0.5, which is approximately half of the long-run price elasticity, -0.5 to -0.6. Their results supported their hypotheses that antismoking regulations reduce cigarette consumption and that people are actually forward looking instead of being myopic.

Other than cigarettes, Grossman (1993); Leung and Phelps (1993); Chaloupka, Grossman, and Sirtlan (1995) studied the alcohol addiction using the rational addiction framework. As mentioned in Grossman (1993), alcohol consumption is not nearly as addictive as cigarette smoking since many persons consume relatively small quantities of alcohol but not cigarettes. More formally, the distribution of alcohol consumption is more continuous than the bimodal distribution of that Becker and Murphy (1988) show is likely to characterize consumption of an addictive good. Both three articles addressed the problem of heavy drinkers, since they appear to be more usual than heavy smoker. Conventional wisdom tended to treat heavy drinkers as irrational people. They are completely not sensitive to price change, not matter in the short run or in the long run. From Leung and Phelps (1993), they reviewed the comprehensive literatures of alcohol addiction models before the invention of rational addiction model, including comparing the elasticity of demand between different alcoholic beverages. They concluded that the pre-existed economic models cannot best explain the alcohol addiction, so revised version of economic models must be introduced, and the quality of the data which being used to do the empirical study should also be addressed.

Combining the results of Grossman (1993) and Leung and Phelps (1993), Chaloupka, Grossman, and Sirtlan (1995) studied the alcohol addiction on teenagers and young adults using rational addiction framework. As mentioned before, Chaloupka, Grossman, and Sirtalan believed that previous theoretical and empirical frameworks of alcohol addiction have generally ignored the addictive aspect of alcohol because alcohol is not nearly as addictive as cigarettes. Therefore, the attempts to apply models of addictive behavior to alcohol demand are inherently more difficult than applications of cigarette demand. To test the rational addiction model, they used data from Monitoring the Future Panels from the University of Michigan's Institute for Social

Research. The panels contain 2400 participants aging from 17 to 27 and the survey conducted every two years from 1976 to 1985. The main reason for them to choose to conduct research among teenagers and young adults is that the prevalence of alcohol dependence and abuse is highest in this age range (Grant et al, 1991). Therefore, addictive models of alcohol consumption may be more relevant to the sample than to a representative sample of population of all ages. In terms of their results, they find that alcohol consumption by teenagers and young adults is addictive in a sense that increase in past or future consumption of alcoholic beverages increases the current consumption of alcoholic beverages. This positive and significant future consumption effect is consistent with the hypothesis of rational addiction and inconsistent with the hypothesis of myopic addiction. Their estimation has an average long-run price elasticity of demand of -0.65 (range from -0.26 to -1.26) and an average short-run price elasticity of demand of -0.41(range from -0.18 to -0.86). The ratio of the long-run price elasticity of demand to the short-run price elasticity of demand is around 1.6, which is less than the usual benchmark of ratio of 2.0 in Becker, Grossman and Murphy (1994). Therefore, their result suggests that alcohol consumption is somewhat less addictive than cigarette smoking.

Other than cigarettes, Chaloupka and Grossman (1998) studied the cocaine addiction on young adults using the same rational addiction framework. Prior to Chaloupka and Grossman's study, few studies address on the effects of price on the use of cocaine, marijuana, heroin or other illegal drugs, and both of them followed the traditional view of substance addiction that people who are addictive to any substances are only care about past consumption and they do not care about the effects of future consumption of drugs on the current consumption of drugs. They use the same dataset from Monitoring the Future Panels as Chaloupka, Grossman, and Sirtlan (1995) did in alcohol addiction study, and they show that cocaine consumption by young adults is addictive in a sense that an increase past or future consumption of cocaine raises the current consumption of cocaine. The positive and significant future consumption effect is consistent with the hypothesis of rational addiction and inconsistent with the hypothesis of myopic addiction. The long-run price elasticity of demand of -1.35 is substantial and larger than the short-run price elasticity of demand of -0.95. Since the long-run price elasticity is only 60% larger than short-run price elasticity, they conclude that cocaine is also not as addictive as cigarettes.

In addition to addictive substance such as cigarette, alcohol and cocaine, many interesting literatures use rational addiction framework to address other substances such as non-addictive goods or non-substance addictive goods. For example, Auld and Grootendorst (2004) study the possibility of fitting milk into rational addiction framework. Although their empirical results using Monte Carlo simulation suggest that milk is as twice addictive as cigarettes, it is actually contradicted to our natural instinct. They find that when using aggregate time series data to estimate the demand function of non-addictive goods such as milk, the rational addiction model tends to yield spurious evidence in favor of rational addiction. Mobilia (1993) studies the behavior of gambling under the rational addiction framework. His dataset is based on per capital attendance on pari-mutuel betting at horse tracks from 1950 through 1987. Although gambling is a non-substance addictive behavior, it still follows the features of addiction, which means greater past consumption of potentially harmful addictive goods such as gambling stimulates current consumption by increasing the marginal utility of current consumption more than the present value of the marginal harm from future consumption. The empirical results of this paper also prove the hypotheses, that long-run price elasticity of gambling demand exceeds the short-run price elasticity of gambling demand, and the cross-price effects are negative.

This topic is inspired by the study of cigarette addiction, done by Gary S. Becker, Kevin M. Murphy and Michael Grossman. The broad topic I will dive into is alcohol addiction behavior. Therefore, the research question I have is that among different age level, whether lower past and future prices of drinking alcohol will raise current alcohol consumption or not?

Three economic papers are the funding base of my research. One is An Empirical Analysis of Cigarette Addiction, by Gary S. Becker, Kevin M. Murphy and Michael Grossman, A Theory of Rational Addiction, by Gary S. Becker and Kevin M. Murphy and An Empirical Analysis of Alcohol Addiction: Results from the Monitoring the Future Panel by Michael Grossman Frank J. Chaloupka and Ismail Sirtalan. A Theory of Rational Addiction is the theoretical frame work of An Empirical Analysis of Cigarette Addiction. Becker and Murphy (1988) created rational addiction model and, together with Grossman, they empirically tested the plausibility of the model using cigarette addiction behavior in the U.S. from 1955 through 1985. Grossman, Chaloupka and Sirtalan (1995) further applied the rational addiction theory to alcohol addiction using the U.S. data from 1976 to 1985.

Although Grossman, Chaloupka and Sirtalan studied the alcohol addiction behavior using rational addiction theory and prove that alcohol addiction can be explained by rational addiction model in 1980s, re-examining the subject using new dataset can always bring new results. Given the fact that alcohol addiction is harmful not only to young people, but also harmful to adults, it is never redundant and also meaningful to study the research question because it can help test the rational addiction theory with much recent settings. As we all know, drinking behavior from 40 or 50 years ago is very different from drinking behavior now, and the alcohol accessibility and quality are also different from the past and now. Therefore, it is also meaningful to test the rational addiction model in relatively new era since Becker and Murphy (1988) already pointed out in their cigarette addiction paper that it is possible to apply a variety of addiction behavior to the rational addiction model no matter how people change. Therefore, my goal is to test and replicate alcohol addiction using rational addiction theory, and if I can show the similar results as Grossman, Chaloupka and Sirtalan (1995) did, the current alcohol behavior is still related to past and future alcohol consumption in 21 centuries. If my results are deviated from the previous results, new results could be implied or new adjustment can be applied to the rational addiction theory.

## Analytical Framework

According to Becker and Murphy (1988) and Becker, Grossman and Murphy (1994), they first assumed that the utility in each period depends on consumption in that period and consumption in the previous period. In particular, the utility function is given by a concave utility function:

$$U(Y_t,\ C_t,\ C_{t-1},\ e_t)$$

Here, Ct is the quantity of addictive goods consumed in period t, Ct-1 is the quantity of addictive goods consumed in period t-1, Yt is the consumption of a composite commodity in period t, and et is the impact of unmeasured life-cycle events. If we assume the composite commodity, Y, as numeraire, if the rate of interest is equal to the rate of time preference, and if the price of cigarettes in period t is denoted by Pt, then we assumed that consumers maximize a lifetime utility function given by

$$\max \Sigma \beta^{t-1} U(Y_t, C_t, C_{t-1}, e_t) = A$$

such that C0 = C0 and

$$\Sigma \beta^{t-1}(Y_t + P_t C_t) = A^0$$

Here again, Yt is consumption of non-addictive good at time or age t, Ct is consumption of addictive good (alcohol in this case) at age t, Ct-1 is alcohol consumption at age t-1, et reflects the effects of unmeasured life cycle variables on utility, and $\beta$ is the time discount factor $\beta = \frac{1}{(1+t)}$, where r is the rate of time preference for the present.

Then, we take the first order conditions of the above lifetime utility function with respect to each variable and we have the marginal utility of other commodities equals the marginal utility of wealth.

$$U_Y(Y_t, C_t, C_{t-1}, e_t) = \lambda$$

And we have the marginal utility of current alcohol consumption plus the discounted marginal effect on next period's utility of today's consumption, equals the current price multiplied by the marginal utility of wealth:

$$U_{C_t}(Y_t, C_t, C_{t-1}, e_t) + U_{C_{t+1}}(Y_{t+1}, C_t, C_{t+1}, e_{t+1}) = \lambda P_t$$

An increase in past alcohol consumption lowers utility if the addiction is harmful, suggesting that $U_{C_{t+1}} < 0$, while an increase in past alcohol consumption increases utility if the addiction is beneficial, suggesting that $U_{C_{t+1}} > 0$. Presumably, according to Becker, Grossman and Murphy (1994), the partial derivative is defined as negative, although the model simply assumes that this term is non-zero. Therefore, in order to reflect the nature of addiction, an increase in past consumption must raise the marginal utility of current consumption $C_t$ in order for an increase in past consumption of C to increase current consumption.

From Becker, Grossman and Murphy (1994), we assume the utility function is quadratic and the rate of time preference for the present is equal to the market rate of interest. By solving the first order condition for Y, and substituting the result into the first order condition for $C_t$, we have a linear demand function for consumption of C that looks like this:

$$C_t = \theta C_{t-1} + \beta\theta C_{t+1} + \theta_1 P_t + \theta_2 e_t + \theta_3 e_{t+1} \quad (1)$$

Here, $P_t$ is the price of $C_t$, and the intercept is suppressed. Since $\theta$ is positive and $\theta_1$ is negative, by concavity of quadratic utility function, current consumption is positively related to past and future consumption and negatively related to current price.

Specifically, $\theta$ measures the effect of an increase in past consumption on the marginal utility of current consumption and the marginal utility of future consumption. Therefore, the larger the value of $\theta$, the greater the degree of reinforcement or addiction of addiction.

The structural demand function (1) is also the basis of empirical analysis of this paper. Note that the Ordinary Least Squares (OLS) estimation of the equation will lead to biased estimation of the parameters since the unobserved lifetime errors $e_t$ that affect utility in each period are likely to be serially correlated. Even if theses variables are not correlated, the same errors $e_t$ affects consumption at all time through the optimization. OLS estimation of the equation will incorrectly imply the effect of past and future consumption of alcohol on current consumption of alcohol, even the true value of $\theta$ is zero.

Fortunately, the equation (1) suggests a way to solve this endogeneity problem, since it implies that current consumption of alcohol is independent of past and future prices when past and future consumption are held constant. That is, any effect of past and future prices on current consumption must come through their effects on past and future consumption. Provided that the unobservable are uncorrelated with prices in these periods, past and future prices are logical instruments for past and future consumption, since past prices directly affect past consumption and future prices directly affect future consumption. Therefore, it is reasonable to use Two-Stage-Least-Squares (2SLS) estimations to estimate the main coefficients $\theta$ and $\theta_1$, with past and future prices serving as instrumental variables for past and future consumption.

According to Grossman, Chaloupka and Sirtalan (1995), the linear demand function implies negative cross price elasticities between alcohol consumption at different points in time. These effects pertain to changes in the price of alcohol in time t on consumption in time t. For example, a reduction in price in period t-1 with prices in all other periods held constant will only increase alcohol consumption in period t-1. As a result, current consumption of alcohol, $C_t$, will increase because $\theta$ is positive. For the same reason, a reduction in price in period t+1 with prices in all other periods held constant will only increase alcohol consumption in period t+1. So, current consumption of alcohol, $C_t$, will also increase because $\beta\theta$ is positive.

In addition, the linear demand function implies that the long-run and short-run responses to a permanent change in price are different. Permanent change in price refers to the changes of price are more than one period. Since a permanent change in price combines a change in the current price with a change in future price, a permanent change in price has a larger effect on current consumption of alcohol than does a temporary change in price, which refers to change in price in single period.

These results can be seen more formally by solving the second-order condition of equation (1). The solution and the various price effects in the model are contained in Appendix A. The solution results in an equation in which consumption in period t depends on prices in all periods. This equation determines the sign of the effects of changes in the price of cigarettes in period r on cigarette consumption in period t. These effects are temporary in nature since prices in other periods are held constant. The temporary own or current price effect must be negative. The short-run price effect describes the response to a change in price in period t and all future periods that is not anticipated until period t. The long-run price effect pertains to a price change in all periods. Since Ct- 1 remains the same if a price change is not anticipated until period t, the long-run price effect must exceed the short- run price effect. The differences between long-run and short-run, temporary and permanent price changes are greater when there is a greater degree of addiction. (Becker, Grossman, & Murphy, 1994)

**Myopic Framework**

While the above analytical framework is based on rational addiction framework, there is another addiction framework called myopic addiction framework that was briefly discussed in Grossman, Chaloupka and Sirtalan (1995). In this model, we assume the consumers are myopic, which means that consumers are only care about past consumption of alcohol and its effects on current consumption. In other words, the myopic individuals fail to consider the impact of current consumption on future utility and future consumption. In analytical framework, the myopic version of the linear demand function is entirely backward: its current consumption of alcohol depends only on current price, past consumption, the marginal utility of wealth, and current unobservable lifetime events. Because of these distinctions, myopic models and rational addiction models have different implications about response to future changes. In particular, rational addiction model decreases the current consumption of alcohol when the future prices are expected to increase, but myopic addiction model does not.

## Data and Empirical Analysis

### Sample Data

From An Empirical Analysis of Alcohol Addiction: Results From The Monitoring The Future Panels, they used individual level data as oppose to aggregate level data because it was more comprehensive. Therefore, National Longitudinal Survey of Youth, 1979 data will be implemented in this paper. This is longitudinal survey that can easily track how individual is developed during a specific time frame. Despite the demographic questions that kept track of each observant, a series questions of Crime & Substance Use were also asked during specific year. Although the Crime & Substance Use questionnaires started from 1988 through 2018, it did not conduct on each year. That means the intervals between each survey year are not the same and using the data directly from 1988 to 2018 will result serious bias. In Grossman, Chaloupka and Sirtalan (1995), they conducted a survey that recorded observations every year from 1976 through 1985. They did the follow up questions for each observants every two years, which means they have observations for each individual in two-year intervals. As I mentioned before, questionnaires from the Crime & Substance Use were conducted with different time intervals. In order to follow the replicated paper and also to mitigate the bias, I choose survey data from 2006, 2008, 2010, 2012, and 2014. They have the same two-year intervals as Grossman, Chaloupka and Sirtalan (1955)'s data and therefore can be used in the following analysis.

The National Longitudinal Survey of Youth, 1979 originally kept track of 12686 observants each year. Not every observant answered all questions on Crime & Substance Use survey. Some participants might answer the survey in 1988, 1992, but not answered in 2012, 2014. Since we want to use the data from 2006, 2008, 2010, 2012, and 2014, we selected participants who only answered the survey in those continuous years. Therefore, after trimming down the data, the number of observations in each year's alcoholic beverage consumption decreases to 1853. Since we have 5 observations for each participant, the total number of observations of alcoholic beverage consumption will be 9265.

In Grossman, Chaloupka and Sirtalan (1995), they pointed out that their samples, which contains participants whose ages only range from 17 to 27, were particularly sensitive to price. Three factors are mentioned in the paper that might cause this problem. First factor is the illegal drinking before drinking age. (Rachel et al, 1980) Second factor is that there were more illegal drug users presented in the sample, and these people consumed more alcohol than those who do not use illegal drugs. (Yamaguchi and Kandel, 1984) The third factor is that alcohol consumption decline with age (Kenkel 1993; Manning, Blumberg, and Moulton 1995) and their sample comes from age 17 to 27. These suggest that the people in their sample are heavy drinkers. Nevertheless, from National Longitudinal Survey of Youth 1979, the sample data I used are different from the sample in Grossman, Chaploupka and Sirtalan (1995). The participants in my sample data range from 41 to 58, which suggests that the sample population might not particularly sensitive to price, since they are all legal drinkers. Second, in my sample, there were less illegal drug users presented and therefore they consume less alcohol than those who do use illegal drugs. Third, the alcohol consumption declines with age and thus participants in my sample might be more resisted to drink.

**Alcoholic Beverage Prices**

In Grossman, Chaloupka and Sirtalan (1995), they used price data from American Chamber of Commerce Researchers Association (ACCRA). The ACCRA collects information on the prices of a number of consumer goods including alcoholic beverages, as well as information on the cost-of-living index in each citiy in the U.S. Since beer is the alcoholic beverage of choice among teenagers and young adults, Grossman, Chaloupka and Sirtalan (1995) chose the price of beer as the representation of alcoholic beverage price. In order to convert nominal price of beer into the real price, they divided the nominal price by a city-specific cost of living index.

In this paper, since the price data from ACCRA is difficult to access, I use the total sales of alcoholic beverage among a certain area divide the total number of alcoholic beverages that are sold in that area to obtain the unit price of alcoholic beverage. The sales of alcoholic beverage come from Consumer Expenditure Survey from U.S. Bureau of Labor Statistics. This survey provides data on expenditures, income, and demographic characteristics of consumers in the United States. In order to retrieve the data from four regions: Northeast, Midwest, South and West, Consumer Expenditure for Geographic data are used. It provides data for the following geographic areas: National, regions, divisions, selected States, selected Metropolitan Statistical Areas

(MSAs), and by Population Size of Area. The regional expenditure data are calculated as two-year basis: it contains the average annual expenditure and characteristics in two years. For example, in order to retrieve the data from 2006, the average annual expenditure and characteristics of 2005 to 2006 are used. For data from 2008, the average annual expenditure and characteristics of 2007 to 2008 are used. For data from 2010, the average annual expenditure and characteristics of 2009 to 2010 are used. For data from 2012, the average annual expenditure and characteristics of 2011 to 2012 are used. For data from 2014, the average annual expenditure and characteristics of 2013 to 2014 are used.

The total number of participants in Consumer Expenditure Survey in each year are roughly 120 million, with 48 percent of male and 52 percent of female. The ages of participants in each survey range from 48 to 50, which falls into the age range in the alcoholic beverage consumption data from National Longitudinal Survey of Youth 1979. The Consumer Expenditure Survey contains the individual level data and does not specify the type of alcoholic beverages each participant spend during each year. Therefore, an overall average alcoholic beverages expenditure for each individual is outlined during each survey in those four regions.

Once I have the individual level of alcoholic beverages expenditure, the total number of alcoholic beverages that are sold within those four regions is required to calculate the unit price of a can of alcoholic beverage. The National Beer Wholesalers Associations provides data for shipments(sales) of malt beverages and per capita consumption by state. The data contains the number of barrels of malt beverages that are shipped to each state and the number of people who are aged more than 21. Since one barrel contains 31 gallons of malt beverages and I use 12oz can of beer as the unit, the total number of alcoholic beverages that are sold within a region can be calculated by multiplying the number of barrels of malt beverages by 31 and 128, and divided it by 12. The total number of sales of alcoholic beverages can be calculated by multiplying the number of people who are aged more than 21 by the individual level of alcoholic beverages expenditures.

The unit price of an alcoholic beverages here is refer to the unit price of a 12oz can beer, as Grossman, Chaloupka and Sirtalan (1995) also used the price of beer to represent the alcoholic beverages. Therefore, to calculate the unit price of a 12oz beer within a region, I use the total number of sales of alcoholic beverages within that region divides the total number of alcoholic beverages that are sold within that region.

**Measurement of Variables**

The number of alcoholic beverages consumed in a year is the dependent variable of the model. This variable is calculated by the product of alcoholic drinks the individual has on a day and the number of days the individual has alcoholic drinks in last month, and multiply it by 12 (to annualize it). Both variables are measured with errors. In some years, the number of alcoholic drinks the individual has on a day is a categorical variable with multiple outcomes: 0 drink, 1 to 4 drinks, 5 to 9 drinks, 10 to 14 drinks, 15 to 19 drinks, 20 to 24 drinks, all the way to 50 or more drinks. It will be converted into continuous variable by assigning midpoints to the closed intervals and a value of 55 to the open-ended intervals. If the variables in some years are already the continuous variables with only one open-ended intervals. The open-ended intervals will be assigned a value that is equal to the lower bound of that interval.

The number of days the individual has alcoholic drinks in last month follows the same logic. In some years, this variable is a categorical variable with multiple outcomes: 0 day, 1 to 4 days, 5 to 9 days, 10 to 14 days, 15 to 19 days, 20 to 24 days, 25 to 29 days, and 30 to 34 days. It will be converted into continuous variable by assigning midpoints to the closed intervals except the last one. The last interval will be assigned a value of 30 just for the sake of convenience. If the variables in some years are already the continuous variables, they will be directly used and remain intact.

In order to match the price of alcoholic drinks to each individual, the current region of residence is also included. The variable is a categorical variable with 4 outcomes: 1 for Northeast, 2 for North Central, 3 for South, 4 for West. Therefore, the price of alcoholic drinks needed to assign to each individual will be the simple average of the price of alcoholic drinks in those states in Northeast for the first outcome. The rest three outcomes will also follow the same patterns.

**Estimation Issues**

Given the natural of the panel data, I estimate the structural demand function (1) with the second lag of the annual number of beers as the measure of past consumption of beer and the second lead of the annual number of beers as the measure of future consumption of beer. (Chaloupka, Grossman & Sirtalan, 1995) Since past and future consumption are endogenous, the equation is fitted by two-stage least squares (2SLS). The instrumental variables in 2SLS consist of the exogenous variables in the model, the second lag of the annual beer price, the second lead of the annual beer price, the second lag and lead of participants' age, and the second lags and the second leads of all time-varying socioeconomic variables. Theses includes the annual income and marital status. The second lag and lead of the beer price and the second lag and lead of age do not provide enough explanatory power to obtain reliable parameter estimates. Probably this is because in a given year, the beer price and the age measures vary only among states, while past and future consumption vary among persons.

A problem with the use of lags and leads of the socioeconomic variables as instruments for past and future consumption is that these variables themselves may not be exogenous. Although it might be true that those socioeconomic variables are exogenous, they could still be corelated with the error terms in the structural demand function (1) or some of those are caused by alcohol consumption. Following the instruction of Chaloupka, Grossman and Sirtalan (1995), they think the marital status is more likely to fall into the category. Therefore, demand function are obtained with and without these variables.

## Empirical Results

Here is a list of variables that I am using for estimation. The clarifications and definitions of the variables are listed below:

- annualcon: it is a continues variable that measures the number of drinks of alcohol in past year
- price: it is a continues variable that measures the real annual beer price from 2006 to 2014 in dollars
- income: it is a continues variable that measures the total income from wages and salary (before taxation) in past calendar year
- age: it is a continues variable that measures the age of the participants
- hispanic: it is a dummy variable that indicates that whether the race identity of the participant is Hispanic or not. With "1" stands for "Yes", and "0" stands for "No"
- black: it is a dummy variable that indicates that whether the race identity of the participant is Black or not. With "1" stands for "Yes", and "0" stands for "No". Here, I omit the choice of white and other races.
- married: it is a dummy variable that indicates the marital status of the participant. "1" stands for the participant is married and "0" stands for the participant is not married.
- separated: it is a dummy variable that indicates the marital status of the participant. "1" stands for the participant is currently separated from his or her spouse and "0" stands for the opposite.

- divorced: it is a dummy variable that indicates the marital status of the participant. "1" stands for the participant is currently divorced with his or her spouse and "0" stands for the participant is not divorced.
- widowed: it is a dummy variable that indicates the marital status of the participant. "1" stands for the participant is widowed and "0" stands for the participant is not widowed. I omit the single status in marital status, which stands for the participant has never gotten married once.
- annual_lag1: it is a continuous variable that indicates the past annual consumption of alcohol. Here, the interval of the lag is 2 years, which means the first lag of annual consumption of alcohol is actually 2 years behind the original period.
- annual_lead1: it is a continuous variable that indicates the future consumption of alcohol. Here, the interval of the lead is 2 years, which means the first lead of annual consumption of alcohol is actually 2 years ahead of the original period.
- price_lag1: it is a continuous variable that serves as an instrument of the past annual consumption of alcohol. Here, the interval of the lag is 2 years, which means the first lag of price of alcohol is actually 2 years behind the original period.
- Price_lead1: it is a continuous variable that serves as an instrument of the future annual consumption of alcohol. Here, the interval of the lead is 2 years, which means the first lead of price of alcohol is actually 2 year ahead of the

original period.

Table 1 shows the summary statistics of each variable. The rest of the tables show the results of the rational addiction model directly by estimating the structural demand function given in the theoretical framework section. Despite the current price of beer, past annual consumption of beer and future consumption of beer, I also include demographic variables such as sex, race, and marital status. In Chaloupka, Grossman and Sirtlan (1995), they also include other variables such as whether the participant is employed or not, whether the participant is frequently engaged in religious activities or not, and number of children the participant has. Although I try to include those in the analysis as well, I can't get the whole data of those variables since some of them are missing in National Longitudinal Survey of Youth, 1979.

Table 2 and table 3 also shows the results of two-stage least squares (2SLS) regressions in which past consumption (the second annual lag of consumption) of beer and future consumption (the second annual lead of consumption) of beer are endogenous. Marital status is excluded from the first regression results and included in the second results. As mentioned in the theoretical framework section, the instruments for past and future consumption of beer are all exogenous variables in the model, the second lag of the beer price and the second lead of the beer price, the second lag and second lead of the participant's age, and all the time-varying socioeconomic variables.

From the 2SLS results, the estimated effects of past and future consumption on current consumption are not significant but positive in both regressions with and without marital status, and the estimated price and age effects are not significant but negative in the first regression, positive in the second regression. Although the results are not significant, the positive past consumption coefficient is consistent with the hypothesis that alcohol consumption is an addictive behavior. The positive future consumption coefficient is consistent with the hypothesis of rational addiction and inconsistent with the hypothesis of myopic addiction. The sum of the past and future consumption coefficients is always smaller than one, suggesting that the short run and long run price elasticity of demand are negative. However, the above assumption might not be true in the second regression since the price and age effects are not significant and positive. Since the results both violate the law of demand and the previous assumption of young people tend to drink more, the socioeconomic variables seem to be exogenous and contain independent information which other exogenous variables do not have.

Table 4 and table 5 shows the results of Ordinary Least Squares regressions in which the past consumption (the second annual lag of consumption) of beer and the future consumption (the second annual lead of consumption) of beer are endogenous. Marital status is excluded from the first regression results and included in the second results. In OLS regression model, past and future consumption of beer are treated as exogenous and included in the model as other variables. The second lag of price and second lead of price are not used in OLS regressions since they do not need price to serve as instruments.

From the results of OLS estimations, past consumption and future consumption of beer are statistically significant, both for OLS estimation with marital status and without marital status. The coefficients for past and future consumption of beer are positive, suggesting that the past and future consumption of beer is positively associate with the current consumption of beer. These results are in favor of the hypothesis that alcohol is an addictive behavior, and they are in consistent with the hypothesis of the rational addiction theory and inconsistent with myopic theory. The statistical estimation of price effect of OLS model is positively associate with the current consumption of beer, which is also contradicted to law of demand like the second regression results of 2SLS. Normally, the price is negatively associate with the demand of a good according to the law of demand. Slightly improvement of OLS estimation is that the coefficient of past and future consumption of beer are slightly larger than the results of 2SLS, suggesting that alcohol might actually be addictive.

Table 6 shows the short run and long run price elasticity of demand at the sample means of price and consumption, some of them violate the law of demand. For 2SLS estimation, the long run price elasticity of demand is -0.0487 (discard the positive result of long run price elasticity), and the short run price elasticity of demand is -0.0341 (discard the positive result of long run price elasticity). For OLS estimation, the long run price elasticity of demand is 0.09905 (range between 0.0875 and 0.1106), and the short run price elasticity of demand is 00457 (range between 0.0406 and 0.0508). Focusing only on the 2SLS estimations, the ratio of the long run elasticity of demand to the short run elasticity of demand is 1.4303. This ratio should be compared to a ratio of approximately 2.00 in the case of rational addiction demand functions for cigarettes (Chaloupka, 1991; Becker, Grossman, and Murphy, 1994) and to a ratio of approximately 1.60 in the case of rational addiction demand functions for alcohol (Chaloupka, Grossman, and Sirtalan, 1995). Since the ratio of the long run price elasticity to the short run price elasticity increases as the degree of addiction increases (Becker, Grossman, and Murphy, 1991), the results I obtained suggest that alcohol consumption is somewhat less addictive than cigarette smoking. The results also suggest that alcohol consumption in elder people is somewhat less addictive than alcohol consumption in younger people, since the long run price elasticity is only 40% larger than the short run price elasticity.

## Conclusion & Discussion

This paper examines the topic of alcohol consumption. Specifically, it empirically tests whether the alcohol consumption is an addictive behavior or not by replicating the Chaloupka, Grossman and Sirtalan 1995's study using rational addiction framework. The main difference between this paper and Chaloupka, Grossman and Sirtalan's study is the dataset. In their study, they use individual level dataset from 1976 to 1985 and the sample age of the participants are aging from 17 to 27. In this study, I use individual level dataset from 2006 to 2014 and the sample age of the participants are aging from 41 to 58. The goal of this paper is to have the same or similar results as the previous study. They are, first, the alcohol consumption is an addictive behavior in the sense that increases in past or future consumption of alcohol cause current consumption of alcohol to rise; second, the alcohol consumption is consistent with the hypothesis of rational addiction and inconsistent with the hypothesis of myopic addiction; third, the long run price elasticity of alcohol demand is larger than short run price elasticity of alcohol demand.

From the results of OLS and 2SLS estimations, one can conclude that although some of the variables are not statistically significant, the 2SLS model at least displayed the similar results as the previous study. The positive past consumption of alcohol supports the hypothesis that alcohol consumption is an addictive behavior. The positive future consumption of alcohol supports the hypothesis of rational addiction and rejects the hypothesis of myopic addiction. The negative short run and long run price elasticity calculated from the results of the first 2SLS estimation, though the difference is small, suggest that people are more sensitive to permanent price change than temporal price change. The negative age effects of the first and second 2SLS estimations further supports the hypothesis that younger people tend to drink more alcohol than elder people. (Grant et al, 1991) The above hypothesis can be further proved by looking at the ratio of long run price elasticity over the short run price elasticity. In Chaloupka, Grossman and Sirtalan 1995's study, the ratio is about 1.60. In this paper, the ratio is 1.43. As mentioned above, the participants I used in this paper are aged from 41 to 58 while in their study, the participants they used are aged from 17 to 27. Therefore, it is reasonable to get a ratio of 1.43 which is smaller than the ratio of 1.60, and proving the hypothesis of young people are active drinkers.

The limitations of this paper can be discovered by the results of OLS estimation and the second 2SLS estimation. From the results of OLS estimation, although including OLS estimation is useful given the potential of endogeneity of socioeconomic variables, the positive coefficients of the price make the estimation violate the law of demand. The unexpected result of second 2SLS estimation could be caused by the biased price data and beer consumption data. From Chaloupka, Grossman and Sirtalan (1995)'s study, their alcohol consumption data come from actual survey among young adults who is currently under the actively drinking age. As mentioned in the literature review part, the younger the person, the easier the person to engage in heavy drinking behavior. In contrast with my dataset, the participants' age in the survey ranges from 41 to 58, which is not as similar as the participants' age in Chaloupka, Grossman and Sirtalan's study. Nevertheless, the biased they have on their data is that almost 38 percent of all cases fall into the open-ended frequency category of 40 or more drinking occasions in the past 12 months. In my sample, most of cases fall into the frequency category of 0 to 4 drinking occasions in the past 12 months.

Additionally, the price of beer contains measurement errors for several reasons. Frist, the unit price of beer is calculated by using total sales of beer in one region divides total number of cans of beer sold in that region. The total sales of beer are calculated by multiplying the population in that region by the average spending on alcoholic beverage per capita in that region. Since the average spending per capita in on region is calculated by random sampling and people participating for alcohol consumption survey is different from people participating for average spending on alcoholic beverage survey, it could lead to biased when calculating the unit price of beer. Second, since the National Longitudinal Survey of Youth 1979 only contains regional geographic data for each individual, even though I have unit price of beer precise to each state, I can only assign the price of beer to each participant based on regional placement.

Also, when calculating the price of alcohol, I choose beer as the standard drink for the participants. This is valid in Chaloupka, Grossman and Sirtalan's study as they assume the primary alcoholic beverages for young adults are beer. However, since the participants in my sample are generally older, it is likely that the beer is not the primary alcoholic beverages for middle aged individuals. Using the price of beer as the general indicator of alcoholic beverages' prices will cause severe biased on the regression results.

Another possible reason that leads second 2SLS estimation and both OLS estimations have positive price effect associate with the current alcohol consumption is the financial crisis. The consumption data I used for this paper comes from 2006 to 2014, where the 2008 financial crisis took place. Though the recession starts at the end of 2017 and last through the middle of 2009, it might still have significant effect on alcoholic beverage consumption and the price. One significant effect of 2008 great recession is the high unemployment rate in the U.S. (Grusky, Western and Wimer, 2011; Mian and Amir, 2010) Since lots of people are unemployed, they will be in great depression and more likely to consume more addictive goods such as alcohol in order to escape from reality. While the increase of price of commodities will certainly decrease the quantity demand of commodities by the law of demand, it is unclear that what effects does the great recession employed to the demand and supply of alcoholic beverages. If instead of quantity demand change, the whole demand curve of alcoholic beverages change, it is likely that while the price of alcoholic beverages increase, the demand of alcoholic beverages also increase (shifting along the supply curve).

## Appendix A

The equation (1) is calculated using Lagrange method and solve the first order condition for quadratic utility function. First, we have quadratic utility function for consuming alcohol is given by:

$$U(Y_t, C_t, C_{t-1}, e_t) = u_y Y_t + u_1 C_t + u_2 C_{t-1} + u_e e_t + \frac{u_{yy}}{2} Y_t^2 + \frac{u_{11}}{2} C_t^2 + \frac{u_{22}}{2} C_{t-1}^2 + \frac{u_{ee}}{2} e_t^2 + u_{1y} Y_t C_t + u_{2y} C_{t-1} Y_t + u_{ye} e_t Y_t + y_{12} C_t C_{t-1} + u_{1e} C_t e_t + u_{2e} C_{t-1} e_t$$

Then, the life time budget constraint a consumer has is given by the following equation:

$$A_0 = \sum_{t=1}^{T} \beta^{t-1} (P_C C_t + Y_t)$$

We set up a Lagrange to maximize the utility level of alcohol consumption at time t. The equation is given by:

$$maxL = \sum_{t=1}^{T} \beta^{t-1}\, U(Y_t, C_t,\, C_{t-1}, e_t\,) + \lambda(A - \sum_{t=1}^{T} \beta^{t-1} (P_C C_t + Y_t))$$

Then, we take the first order condition of the above Lagrange maximization equation, we have:

$$\frac{\partial L}{\partial C_t} = \frac{\partial U(Y_t, C_t, C_{t-1}, e_t\,)}{\partial C_t} + \beta \frac{\partial U(P_D C_t + Y_t\,)}{\partial C_t} - \lambda P_C = 0$$

The resulting expression for alcohol demand at time t, Ct, deriving from the FOCs and the utility function is given by the following:

$$C_t = \theta C_{t-1} + \beta\theta C_{t+1} + \theta_1 P_t + \theta_2 e_t + \theta_3 e_{t+1}$$

where

$$\theta = \frac{-(u_{12}u_{yy} - u_{1y}u_{2y})}{(u_{11}u_{yy} - u_{1y}^2) + \beta(u_{22}u_{yy} - u_{2y}^2)}$$

$$\theta_1 = \frac{u_{yy}\lambda}{(u_{11}u_{yy} - u_{1y}^2) + \beta(u_{22}u_{yy} - u_{2y}^2)}$$

$$\theta_2 = \frac{-(u_{yy}u_{1e} - u_{1y}u_{ey})}{(u_{11}u_{yy} - u_{1y}^2) + \beta(u_{22}u_{yy} - u_{2y}^2)}$$

$$\theta_3 = \frac{-\beta(u_{yy}u_{2e} - u_{2y}u_{2e})}{(u_{11}u_{yy} - u_{1y}^2) + \beta(u_{22}u_{yy} - u_{2y}^2)}$$

By solving the second order difference equation for the structural demand function for alcohol consumption (equation (1) in the text), the roots can be represented as the following:

$$\phi_1 = \frac{1 - (1 - 4\theta^2\beta)^{\frac{1}{2}}}{2\theta}$$

$$\phi_2 = \frac{1 + (1 - 4\theta^2\beta)^{\frac{1}{2}}}{2\theta}$$

The price effects on consumption in period t is denoted as:

$$\frac{dC_t}{dP_t} = \frac{\theta_1}{\theta(1 - \phi_1)\phi_2}$$

This equation shows the short-run price effect, defined as the impact on consumption of a reduction in current price and all future prices, with past consumption held constant. The long run price effect can be denoted as:

$$\frac{dC_\infty}{dP_t} = \frac{\theta_1}{\theta(1 - \phi_1)(\phi_2 - 1)}$$

Appendix B

**Table 1 Descriptive Statistics**

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| year | 9265 | 2010 | 2.829 | 2006 | 2014 |
| income | 9265 | 59072.87 | 65511.528 | 0 | 370314 |
| region | 9265 | 2.612 | .996 | 1 | 4 |
| age | 9265 | 48.844 | 3.855 | 41 | 58 |
| current consumption | 9265 | 317.94 | 414.095 | 12 | 7200 |
| race | 9265 | 2.479 | .757 | 1 | 3 |
| sex | 9265 | 1.437 | .496 | 1 | 2 |
| price | 9265 | 1.447 | .297 | 1.041 | 1.996 |
| past consumption | 7412 | 313.418 | 405.623 | 12 | 5760 |
| future consumption | 7412 | 323.399 | 416.919 | 12 | 7200 |
| price lag1 | 7412 | 1.421 | .291 | 1.041 | 1.945 |
| price lead1 | 7412 | 1.453 | .294 | 1.092 | 1.996 |
| male | 9265 | .563 | .496 | 0 | 1 |
| hispanic | 9265 | .161 | .368 | 0 | 1 |
| black | 9265 | .198 | .399 | 0 | 1 |
| married | 9265 | .653 | .476 | 0 | 1 |
| seperated | 9265 | .028 | .164 | 0 | 1 |
| divorced | 9265 | .18 | .384 | 0 | 1 |

| | | | | | |
|---|---|---|---|---|---|
| widowed | 9265 | .013 | .113 | 0 | 1 |

**Table 2 Instrumental variables (2SLS) regression with marital status**

| current con | Coef. | St.Err. | t-value | p-value | [95% Conf | Interval] | Sig |
|---|---|---|---|---|---|---|---|
| past con | .28 | .21 | 1.33 | .183 | -.132 | .692 | |
| future con | .3 | .184 | 1.63 | .104 | -.062 | .661 | |
| price | -5.247 | 14.531 | -0.36 | .718 | -33.733 | 23.24 | |
| income | 0 | 0 | -1.75 | .081 | 0 | 0 | * |
| age | -.685 | 1.324 | -0.52 | .605 | -3.281 | 1.911 | |
| hispanic | -25.209 | 14.365 | -1.75 | .079 | -53.369 | 2.952 | * |
| black | -22.222 | 13.816 | -1.61 | .108 | -49.307 | 4.863 | |
| married | -59.263 | 20.247 | -2.93 | .003 | -98.955 | -19.571 | *** |
| seperated | -34.536 | 27.859 | -1.24 | .215 | -89.152 | 20.079 | |
| divorced | -22.813 | 15.199 | -1.50 | .133 | -52.609 | 6.984 | |
| widowed | -59.599 | 38.99 | -1.53 | .126 | -136.033 | 16.836 | |
| Constant | 237.677 | 93.19 | 2.55 | .011 | 54.989 | 420.365 | ** |

| | | | |
|---|---|---|---|
| Mean dependent var | 319.191 | SD dependent var | 406.706 |
| R-squared | 0.529 | Number of obs | 5559.000 |
| F-test | 20.615 | Prob > F | 0.000 |

**** p<.01, ** p<.05, * p<.1*

**Table 3 Instrumental variables (2SLS) regression without marital status**

| current con | Coef. | St.Err. | t-value | p-value | [95% Conf | Interval] | Sig |
|---|---|---|---|---|---|---|---|
| past con | .704 | .297 | 2.37 | .018 | .122 | 1.285 | ** |
| future con | .186 | .226 | 0.82 | .41 | -.257 | .629 | |
| price | 4.817 | 16.002 | 0.30 | .763 | -26.553 | 36.186 | |
| income | 0 | 0 | -0.39 | .699 | 0 | 0 | |
| age | -.65 | 1.328 | -0.49 | .625 | -3.253 | 1.953 | |
| hispanic | -6.799 | 18.553 | -0.37 | .714 | -43.171 | 29.572 | |
| black | -2.751 | 13.88 | -0.20 | .843 | -29.961 | 24.46 | |
| Constant | 71.615 | 125.13 | 0.57 | .567 | -173.689 | 316.919 | |

| | | | |
|---|---|---|---|
| Mean dependent var | 319.191 | SD dependent var | 406.706 |
| R-squared | 0.530 | Number of obs | 5559.000 |
| F-test | 11.535 | Prob > F | 0.000 |

**** p<.01, ** p<.05, * p<.1*

**Table 4 Linear regression with marital status**

| current con | Coef. | St.Err. | t-value | p-value | [95% Conf | Interval] | Sig |
|---|---|---|---|---|---|---|---|
| past con | .417 | .012 | 36.01 | 0 | .394 | .44 | *** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| future con | .414 | .011 | 37.59 | 0 | .393 | .436 | *** |
| price | 3.249 | 12.922 | 0.25 | .802 | -22.083 | 28.58 | |
| income | 0 | 0 | -0.96 | .335 | 0 | 0 | |
| age | -.882 | 1.22 | -0.72 | .47 | -3.273 | 1.509 | |
| hispanic | -8.521 | 10.031 | -0.85 | .396 | -28.187 | 11.144 | |
| black | -6.785 | 9.734 | -0.70 | .486 | -25.868 | 12.298 | |
| married | -31.035 | 11.36 | -2.73 | .006 | -53.304 | -8.765 | *** |
| seperated | -14.33 | 23.893 | -0.60 | .549 | -61.17 | 32.51 | |
| divorced | -12.425 | 13.111 | -0.95 | .343 | -38.128 | 13.278 | |
| widowed | -30.438 | 33.168 | -0.92 | .359 | -95.462 | 34.585 | |
| Constant | 124.654 | 60.84 | 2.05 | .041 | 5.385 | 243.924 | ** |

| | | | |
|---|---|---|---|
| Mean dependent var | 319.191 | SD dependent var | 406.706 |
| R-squared | 0.580 | Number of obs | 5559.000 |
| F-test | 697.189 | Prob > F | 0.000 |
| Akaike crit. (AIC) | 77770.500 | Bayesian crit. (BIC) | 77849.978 |

**** p<.01, ** p<.05, * p<.1*

**Table 5 Linear regression without marital status**

| current con | Coef. | St.Err. | t-value | p-value | [95% Conf | Interval] | Sig |
|---|---|---|---|---|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| past con | .419 | .012 | 36.21 | 0 | .396 | .441 | *** |
| future con | .416 | .011 | 37.73 | 0 | .394 | .437 | *** |
| price | 4.009 | 12.889 | 0.31 | .756 | -21.258 | 29.276 | |
| income | 0 | 0 | -1.30 | .193 | 0 | 0 | |
| age | -1.017 | 1.218 | -0.83 | .404 | -3.405 | 1.371 | |
| hispanic | -5.832 | 9.994 | -0.58 | .56 | -25.424 | 13.759 | |
| black | .758 | 9.349 | 0.08 | .935 | -17.569 | 19.086 | |
| Constant | 105.021 | 60.174 | 1.75 | .081 | -12.943 | 222.985 | * |

| | | | |
|---|---|---|---|
| Mean dependent var | 319.191 | SD dependent var | 406.706 |
| R-squared | 0.580 | Number of obs | 5559.000 |
| F-test | 1093.127 | Prob > F | 0.000 |
| Akaike crit. (AIC) | 77772.059 | Bayesian crit. (BIC) | 77825.044 |

*** *p<.01, *** *p<.05, ** *p<.1*

**Table 6 Price Elasticity of Demand**

| | Two Stage Least Squares | | Ordinary Least Squares | |
|---|---|---|---|---|
| | With Marriage | Without Marriage | With Marriage | Without Marriage |
| Long Run | -0.0487 | 0.1993 | 0.0875 | 0.1106 |
| Short Run | -0.0341 | 0.0333 | 0.0406 | 0.0508 |

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