RATIONALLY ADDICTED TO CIGARETTES, ALCOHOL AND COFFEE? A PSEUDO PANEL APPROACH

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In this paper, using pseudo panel data we analyze the relation between cigarette, alcohol, and coffee consumption within the rational addiction framework. Our purpose in this study is twofold. First, we want to get more insights about behavioral processes concerning cigarette, alcohol and coffee consumption. Second, we hope that our attempt to generalize rational addiction model to include three addictive goods will be useful to generate further research in the related literature. We found that cross price elasticity of cigarette with respect to alcohol price is negative, while cross price elasticity of alcohol with respect to cigarette price is positive. We believe that drinking works as a trigger for smoking especially in social settings like bars while it is also possible that people who want to cut cigarette consumption might increase alcohol consumption to cope with resulting stress, which induces an asymmetry in cross price elasticities. We did not find a strong relation between coffee consumption and the consumption of cigarette and alcohol. This finding does not rule out the possibility that coffee and cigarette are complements for certain people. However there is not a significant complementarity relationship when we look at the whole population.

Key words: *cigarette, alcohol, coffee, rational addiction, pseudo panel*

When modeling demand for addictive (habit forming) goods the most popular framework is the rational addiction model proposed by Becker and Murphy (1988). Becker and Murphy (1988) claim that addictions to harmful substances are still rational as the decision involve forward-looking maximization of utility. Rational addiction model differs from myopic models of addictive behavior in the sense that it does not only account for habit formation, but it also involves rationality. In myopic models, past consumption stimulates current consumption, but individuals ignore future when making consumption decisions. In the rational addiction model, consumer is aware of future consequences of addiction and weighs them in making current consumption choice. In the rational addiction model, both the past and anticipated future consumption affect current consumption positively.

Bask and Melkersson (2004) extended rational addiction model to allow for multi-commodity addictions and estimated demand for two addictive goods: alcohol and cigarettes. This paper will further extend their attempt by analyzing the interdependence among more than two addictive goods in a rational addiction framework. In particular, we focus on the relation between cigarette, alcohol and coffee consumption.

Rational addiction model has been previously applied to cigarette consumption (e.g., Becker, Grossman and Murphy 1994), alcohol consumption (e.g., Grossman, Chaloupka and Sirtalan 1998) and coffee consumption (e.g., Olekalns and Bardsley 1996) separately. Many papers claim interdependence between cigarette and alcohol consumption using myopic or rational addiction models. On the other hand, to the best of our knowledge there is no paper that uses a theoretical framework to analyze the relation between the consumption of coffee and other addictive goods like cigarettes and alcohol. However, Zavela et al, (1990) point out some laboratory experiments that suggest dependence between cigarette and coffee consumption:

> **"In a study by Marshall, Epstein, and Green (1980), for instance, subjects who received coffee in an experimental setting smoked more cigarettes than those who were provided with no liquids, water, or a coffee substitute. Emurian, Nellis, Brady, and Ray (1982) also demonstrated in a laboratory experiment that cigarette smoking was more likely to occur after than before a person had consumed coffee." (Zavela et al 1990, p 842).**

Zavela et al. (1990) examine the relation between cigarette, alcohol, and coffee consumption among army personnel. They find that for women cigarette and alcohol consumptions are positively correlated; but for men cigarette and coffee consumptions are positively correlated. In addition, they find a consistent pattern of abstention from coffee and alcohol (or moderate alcohol consumption) among nonsmokers.

In this paper, we analyze the relation between cigarette, alcohol and coffee consumption in a rational addiction framework using Consumer Expenditure Survey(CEX) data.

CEX data is at the household level. Although household level panel data have many advantages compared to aggregate data, they generally span short time periods, suffer from measurement error and are subject to attrition bias. In order to avoid these problems, we will employ a pseudo panel data approach in this study. While pseudo panel is disaggregated enough, it has main advantages compared to panel data:

- It avoids the attrition problem that many panel surveys suffer from.
- There may be less bias due to measurement error problems as we are typically working with a group average.
- It eliminates the econometric difficulties due to censoring.

Our purpose in this study is twofold. First, we want to get more insights about behavioral processes concerning cigarette, alcohol and coffee consumption. Second, we hope that our attempt to generalize rational addiction model to include three addictive goods will be useful to generate further research in the related literature (e.g., interdependence among cigarettes, alcohol and marijuana or interdependence among cigarettes and different types of alcoholic beverages such as beer and wine).

Theoretical Model

A consumer is said to be addicted to a consumption good, if an increase in past consumption increases current consumption. Studies of harmful addictions have usually found reinforcement. Reinforcement means that an increase in the past consumption increases craving for current consumption. Reinforcement implies that consumption of the same good at different time periods are complements. Since rational consumers also consider future negative consequences of harmful behavior, the reinforcement effect should be high enough in order to justify current consumption of harmful addictive goods.

Following Bask and Melkersson (2004), we assume:

(1) $U_{it} = U(C_{it}, A_{it}, K_{it}, S_{it}, D_{it}, L_{it}, N_{it})$

where C_{it}, A_{it} and K_{it} are the quantities of cigarettes, alcohol and coffee consumed;

S_{it}, D_{it} and L_{it} are the habit stocks of cigarettes, alcohol and coffee respectively;

N_{it} is the consumption of a non-addictive composite commodity in period t.

We assume a strictly concave utility function. The marginal utility derived from each good is assumed to be positive (i.e., $U_C > 0$, $U_A > 0$, $U_K > 0$ and $U_N > 0$; concavity implies $U_{CC} < 0$, $U_{AA} < 0$, $U_{KK} < 0$ and $U_{NN} < 0$). Following rational addiction literature, we assume that habit stocks of cigarettes and alcohol affect current utility negatively due to their adverse health effects (i.e. U_S<0 and $U_D < 0$; concavity implies $U_{SS} < 0$ and $U_{DD} < 0$). Since inverse health effects of coffee use are not significant, we don't impose any assumptions on the marginal utility of habit stocks of coffee.

Reinforcement implies $U_{CS} > 0$, $U_{AD} > 0$ *and* $U_{KL} > 0$. Cigarette, alcohol and coffee consumption are assumed to have no effect on the marginal utility derived from the consumption of the composite commodity (i.e. $U_{CN} = U_{AN} = U_{KN} = U_{SN} = U_{DN} = U_{LN} = 0$).

We expect that cigarette and coffee are complements, U_{CK}> 0 ; while alcohol and coffee are substitutes, U_{AK}< 0. When the level of coffee consumption does not affect cigarette consumption, $U_{CK} = 0$. When the level of coffee consumption does not affect alcohol consumption, $U_{AK} = 0$.

The intertemporal budget constraint is

$$(2) \qquad \sum_{t=1}^{\infty} \beta^{t-1} \left(P_{C_t} C_{it} + P_{A_t} A_{it} + P_{K_t} K_{it} + N_{it} \right) = W_i$$

where $\beta = 1/(1+r)$ with r being the discount rate, P_{C_t}, P_{A_t} and $P_{K_t}$are prices of cigarettes, alcohol and coffee respectively, W_i is the present value of wealth. As in previous studies, we assume that the discount rate is equal to the interest rate. The composite commodity, N, is taken as numeraire.

The consumer's problem is:

$$(3) \qquad \max \quad \sum_{t=1}^{\infty} \beta^{t-1} U \left(C_{it}, A_{it}, K_{it}, S_{it}, D_{it}, L_{it}, N_{it} \right)$$

$$s.t. \quad \sum_{t=1}^{\infty} \beta^{t-1} \left(P_{C_t} C_{it} + P_{A_t} A_{it} + P_{K_t} K_{it} + N_{it} \right) = W_i$$

Following previous studies, we assume that $S_{it} = C_{it-1}$ and $D_{it} = A_{it-1}$. When the utility function is quadratic, solving equation (3) generates following demand equations:

$$(4) \quad C_{it} = \alpha_{1i} + \beta_{10} + \beta_{11} C_{it-1} + \beta_{12} C_{it+1} + \beta_{13} A_{it-1} + \beta_{14} A_{it} + \beta_{15} A_{it+1} + \beta_{16} K_{it-1} + \beta_{17} K_{it} + \beta_{18} K_{it+1} + \beta_{19} P_{Ct} + u_{1it}$$

$$(5) \quad A_{it} = \alpha_{2i} + \beta_{20} + \beta_{21} A_{it-1} + \beta_{22} A_{it+1} + \beta_{23} C_{it-1} + \beta_{24} C_{it} + \beta_{25} C_{it+1} + \beta_{26} K_{it-1} + \beta_{27} K_{it} + \beta_{28} K_{it+1} + \beta_{29} P_{At} + u_{2it}$$

$$(6) \quad K_{it} = \alpha_{3i} + \beta_{30} + \beta_{31} K_{it-1} + \beta_{32} K_{it+1} + \beta_{33} C_{it-1} + \beta_{34} C_{it} + \beta_{35} C_{it+1} + \beta_{36} A_{it-1} + \beta_{37} A_{it} + \beta_{38} A_{it+1} + \beta_{39} P_{At} + u_{3it}$$

Economic theory implies $\beta_{k6} < 0$, k =1,2,3. Rational addiction implies $\beta_{k1} > \beta_{k2} > 0$. $\beta_{k4} > 0$ if cigarettes and alcoholic beverages are complements, $\beta_{k4} < 0$ if they are substitutes, and $\beta_{k4} = 0$ if consumption of cigarette and alcoholic beverages do not depend on each other with k=1,2. $\beta_{34} > 0$ if coffee and cigarette are complements. $\beta_{37} < 0$ if coffee and alcohol are substitutes. If $\beta_{13} > 0$ alcohol consumption is a gateway for cigarette consumption, if $\beta_{23} > 0$ cigarette consumption is a gateway for alcohol consumption.[1]

Data

The main data source is the Consumer Expenditure Survey (CEX) which is conducted by U.S. Bureau of Labor Statistics (BLS).

Consumer Expenditure Survey (CEX): Diary Component

In the academic literature, CEX data have been used to study a variety of issues from life-cycle hypothesis to consumer demand (e.g. Nicol 2003; Villaverde and Krueger 2007). The CEX consists of a Diary survey and an Interview survey. Diary component is used in this study. The

[1] Pacula (1997) investigates the so called “gateway effect”: consumption of a legal addictive substance may lead to the later use of an illicit addictive substance. As pointed by Pierani and Tiezzi (2009) the same effect can be thought to apply between cigarette and alcohol.

Diary component is completed by the consumer units (CUs) for two consecutive one-week periods. The survey is designed to constitute a representative sample of U.S. population in each quarter. The data contains information on CU demographic characteristics and expenditures. The list and the definitions of the demographic variables used in this study are given in Appendix A. Cigarette, alcohol and coffee expenditures, together with price variables, are used to calculate the consumption levels of cigarette, alcohol and coffee (i.e. cigarette consumption= cigarette expenditure/ cigarette price).

Price Variables

Since price data are not collected in CEX, price variables used in our analysis are collected from other data sources. All price variables are deflated by Consumer Price Index (CPI) for all items reported in BLS webpage.

Annual state level cigarette prices are from Orzechowski and Walker (2007). Prices are weighted averages for a pack of 20 cigarettes. Prices are inclusive of state-level excise taxes applied to cigarettes but are exclusive of local cigarette taxes. To add monthly variation to annual prices we use “monthly CPI for cigarettes” reported in BLS webpage. For each CU, we weight annual prices by the average CPI of the quarter in which the cigarette expenditure is reported. We merge CEX data and price data by state id variables.

We don’t have state level or household level prices available for alcoholic beverages. To obtain alcoholic beverages prices, we construct Lewbel(1989) price indices that enable us to have household specific price variation. [2] Lewbel price indices are calculated using expenditure shares each household faces for different subcategories of alcoholic beverages, i.e. beer at home, wine at restaurant, etc (for details see Appendix B).

[2] Hoderlein and Mihaleva (2008) show that Lewbel price indices produce superior empirical results compared to the results obtained using traditional aggregate price indices.

For coffee, we use (monthly) regional coffee prices reported at BLS webpage. We merge CEX data and price data by region codes.

Sample Selection Criteria

In CEX data, Census Bureau suppresses the value of the variable, STATE, which identifies the state of residence, for some observations to meet the Census Disclosure Review Board's criterion that the smallest geographically identifiable area have a population of at least 100,000. On approximately 17 percent of the records the STATE variable is blank and approximately 4 percent of STATE codes are replaced with codes of states other than the state where the CU resides. Because we use STATE information to match CU's with state level cigarette prices, the observations with missing and recoded STATE variables are dropped.

Methodology

The advantages of using panel data to estimate models of individual behavior have been widely stressed in the literature. However, individual panel data generally span short time periods, suffer from measurement error and are subject to attrition bias. In order to avoid these problems, Deaton (1985) suggested pseudo panel data approach as an alternative way to estimate models of individual behavior.

The pseudo-panel approach is a relatively new econometric method for estimating dynamic demand models. It is based on grouping individuals into cohorts and then treating cohort averages as observations in a panel. It enables us to follow cohorts of individuals over repeated cross-sectional surveys. Because repeated cross-sectional surveys are typically over longer time-periods than true panels, pseudo panel allows us to estimate models over longer time periods. Moreover, averaging within cohorts eliminates individual-level measurement error.

In pseudo-panel analysis, because cohorts are followed over time, they are constructed based on characteristics that are time invariant, such as geographic region, birth year or the education level of the reference person. When we allocate individuals into cohorts, we face a trade-off between the number of cohorts and the number of individuals within cohorts. If individuals are allocated to a large number of cohorts, there will be a few observations remained in the cohorts which might induce biased estimators. On the other hand, if a few number of cohorts is chosen to have a large number of observations per cohort, individuals within a cohort might be heterogeneous, which might cause inefficiency. Thus, the challenge in constructing a pseudo panel is to find the optimal choice between the numbers of cohorts, and the number of individuals within cohorts. Ideally the optimal choice should minimize the heterogeneity within each cohort but maximize the heterogeneity among them. In that case, pseudo-panels lead to consistent and efficient estimators without the problems associated with true panels.

In most of the applied pseudo-panel studies, the sample is divided into small number of cohorts with a large number of observations in each (i.e. Browning, Deaton and Irish 1985; Blundell, Browning and Meghir 1994; Propper, Rees and Green 2001). Verbeek and Nijman (1992) showed that when cohorts contain at least 100 individuals and the time variation in the cohort means is sufficiently large, the bias in the standard fixed effects estimator will be small and can be ignored. This is the approach we take in this study.

We allocate households into cohorts based on geographic region and gender. For example, females in northeast would form one cohort and males in northeast would form another cohort. The resulting pseudo panel consists of a total of 224 observations over 8 cohorts (4 regions times 2 gender) and 28 quarters (from the first quarter of 2002 to the last quarter of 2008). This allocation results in an average cohort size of at least 100 individuals.

Taking cohort averages of equations (4) - (6) over n_c individuals observed in cohort c at time t results in:

(7) $$\bar{C}_{c(t),t} = \alpha_{1c} + \beta_{10} + \beta_{11}\bar{C}_{c(t),t-1} + \beta_{12}\bar{C}_{c(t),t+1} + \beta_{13}\bar{A}_{c(t),t-1} + \beta_{14}\bar{A}_{c(t),t} + \beta_{15}\bar{A}_{c(t),t+1} + \beta_{16}\bar{K}_{c(t),t-1} + \beta_{17}\bar{K}_{c(t),t} + \beta_{18}\bar{K}_{c(t),t+1} + \beta_{19} P_{Ct} + \bar{u}_{1c(t),t}$$

(8) $$\bar{A}_{c(t),t} = \alpha_{2c} + \beta_{20} + \beta_{21}\bar{A}_{c(t),t-1} + \beta_{22}\bar{A}_{c(t),t+1} + \beta_{23}\bar{C}_{c(t),t-1} + \beta_{24}\bar{C}_{c(t),t} + \beta_{25}\bar{C}_{c(t),t+1} + \beta_{26}\bar{K}_{c(t),t-1} + \beta_{27}\bar{K}_{c(t),t} + \beta_{28}\bar{K}_{c(t),t+1} + \beta_{29} P_{At} + \bar{u}_{2c(t),t}$$

(9) $$\bar{K}_{c(t),t} = \alpha_{3c} + \beta_{30} + \beta_{31}\bar{K}_{c(t),t-1} + \beta_{32}\bar{K}_{c(t),t+1} + \beta_{33}\bar{C}_{c(t),t-1} + \beta_{34}\bar{C}_{c(t),t} + \beta_{35}\bar{C}_{c(t),t+1} + \beta_{36}\bar{A}_{c(t),t-1} + \beta_{37}\bar{A}_{c(t),t} + \beta_{38}\bar{A}_{c(t),t+1} + \beta_{39} P_{Kt} + \bar{u}_{23c(t),t}$$

With repeated cross-sections, different individuals are observed at each time period. As a result, the lagged and lead variables are not observed for the individuals in cohort c at time t. Therefore following previous literature, we replace these sample means of the unobserved variables with the sample means of the individuals at time t−1, and t+1 respectively leading to the following equations:

(10) $$\bar{C}_{c(t),t} = \alpha_{1c} + \beta_{10} + \beta_{11}\bar{C}_{c(t-1),t-1} + \beta_{12}\bar{C}_{c(t+1),t+1} + \beta_{13}\bar{A}_{c(t-1),t-1} + \beta_{14}\bar{A}_{c(t),t} + \beta_{15}\bar{A}_{c(t+1),t+1} + \beta_{16}\bar{K}_{c(t-1),t-1} + \beta_{17}\bar{K}_{c(t),t} + \beta_{18}\bar{K}_{c(t+1),t+1} + \beta_{19} P_{Ct} + \bar{u}_{1c(t),t}$$

(11) $$\bar{A}_{c(t),t} = \alpha_{2c} + \beta_{20} + \beta_{21}\bar{A}_{c(t-1),t-1} + \beta_{22}\bar{A}_{c(t+1),t+1} + \beta_{23}\bar{C}_{c(t-1),t-1} + \beta_{24}\bar{C}_{c(t),t} + \beta_{25}\bar{C}_{c(t+1),t+1} + \beta_{26}\bar{K}_{c(t-1),t-1} + \beta_{27}\bar{K}_{c(t),t} + \beta_{28}\bar{K}_{c(t+1),t+1} + \beta_{29} P_{At} + \bar{u}_{2c(t),t}$$

(12) $$\bar{K}_{c(t),t} = \alpha_{3c} + \beta_{30} + \beta_{31}\bar{K}_{c(t-1),t-1} + \beta_{32}\bar{K}_{c(t+1),t+1} + \beta_{33}\bar{C}_{c(t-1),t-1} + \beta_{34}\bar{C}_{c(t),t} + \beta_{35}\bar{C}_{c(t+1),t+1} + \beta_{36}\bar{A}_{c(t-1),t-1} + \beta_{37}\bar{A}_{c(t),t} + \beta_{38}\bar{A}_{c(t+1),t+1} + \beta_{39} P_{Kt} + \bar{u}_{3c(t),t}$$

In the dynamic pseudo-panel data model, fixed effects estimator is consistent when $n_c \rightarrow \infty$ (McKenzie 2004). In our sample the number of observations in each cohort is large. Thus fixed effects estimators are calculated.

In the sample, the number of households in each cohort/time period are not the same, which might cause heteroskedasticity. To correct for that, following Dargay (2007), all cohort variables are weighted by the square root of the number of households in each cohort.

Results

We have carried out different sets of estimations. First, the model in equations (10) - (12) is estimated as separate structural equations. The results are shown in Table 1. Cigarette demand is consistent with rational addiction. In the cigarette demand equation, current consumption is positively affected by lagged and lead consumption. The coefficient on lagged consumption is higher than the lead consumption coefficient which means the rate of intertemporal preference is positive. In the cigarette demand equation, lagged alcohol consumption is positive and significant which suggests alcohol consumption is a gateway to cigarette consumption.

Alcohol demand is consistent with addiction, but not consistent with rationality. In the alcohol demand equation, lagged consumption has a positive coefficient, but lead consumption has a negative coefficient.

Coffee demand is also consistent with rational addiction. In the coffee demand equation, both lagged and lead consumption has a positive and significant coefficient.

The long run price and income elasticities calculated at the sample mean are shown in Table 2. The long run own price elasticities are negative for all three goods. Cigarette and coffee have inelastic demands while alcohol demand is elastic and highly significant. It is likely that most alcoholic beverage drinkers are just social drinkers, that is why alcohol demand is elastic in the long-run. The income elasticity is positive and less than one for all three goods.

Following Bask and Melkersson 2004, we combine equations (10) - (12) to estimate a semi-reduced system.

$$(13) \quad \bar{C}_{ct} = \alpha_{1c} + \beta_{10} + \beta_{11}\,\bar{C}_{ct-1} + \beta_{12}\bar{C}_{ct+1} + \beta_{13}\bar{A}_{ct-1} + \beta_{14}\bar{A}_{ct+1} + \beta_{15}\bar{K}_{ct-1} + \beta_{16}\bar{K}_{ct+1} + \beta_{17}\,P_{Ct} + \beta_{17}\,P_{At} + \beta_{17}\,P_{Kt} + \bar{u}_{1ct}$$

$$(14) \quad \bar{A}_{ct} = \alpha_{2c} + \beta_{20} + \beta_{21}\,\bar{A}_{ct-1} + \beta_{22}\bar{A}_{c\,t+1} + \beta_{23}\bar{C}_{ct-1} + \beta_{24}\bar{C}_{ct+1} + \beta_{25}\bar{K}_{ct-1} + \beta_{26}\bar{K}_{ct+1} + \beta_{27}\,P_{At} + \beta_{28}\,P_{Ct} + \beta_{29}\,P_{Kt} + \bar{u}_{2ct}$$

$$(15) \quad \bar{K}_{ct} = \alpha_{3c} + \beta_{30} + \beta_{31}\,\bar{K}_{ct-1} + \beta_{32}\bar{K}_{c\,t+1} + \beta_{33}\bar{C}_{ct-1} + \beta_{34}\bar{C}_{ct+1} + \beta_{35}\bar{A}_{ct-1} + \beta_{36}\bar{A}_{ct+1} + \beta_{37}\,P_{Kt} + \beta_{38}\,P_{Ct} + \beta_{39}\,P_{At} + \bar{u}_{3ct}$$

The parameters in these equations are non-linear functions of the parameters in Equations (10) - (12), thus we don’t have prior expectations for their signs. Instead, we should focus on the resulting long-run demand elasticities.

The results for own price elasticities and income elasticities are similar to the ones that we obtained using separate equations (see Table 3). The cross price elasticity of cigarette with respect to alcohol price is negative and significant, while the cross price elasticity of alcohol with respect to cigarette price is positive and insignificant. We believe that an important number of smokers are just social smokers who smoke when they drink and socialize. Thus a change in alcohol prices is likely to influence their alcohol consumption and thus their cigarette consumption as cigarettes and alcohol are complements for them. In addition we found that alcohol is a gateway for cigarette which further reinforces our conclusion concerning the effect of alcohol consumption on cigarette consumption.

The cross price elasticities of coffee not significant which suggests that there is not a strong relation between coffee consumption and the consumption of cigarettes and alcohol. This finding does not rule out the possibility that coffee and cigarette are complements for certain people. However there is not a significant complementarity relationship when we look at the whole population. Thus policies regarding smoking such as excise taxes or smoking bans are not likely to have a significant effect on the overall coffee consumption.

Because we use household level data, we were able to analyze how demographics affect consumption. In the cigarette demand equation, coefficients on fam_size and perslt18 is significant. As family size increases household cigarette consumption increases. When the number of individuals less than 18 in CU increases cigarette consumption decreases. This might suggest that families with younger children are more concerned about negative health effects of passive smoking.

In the alcohol demand equation, age has a positive and significant coefficient which suggests a positive relation between age and alcohol consumption. We also observe that white and single people drink more.

As a robustness check, we replicated estimations using region-birth cohorts instead of region-gender cohorts. We use three wide birth cohorts. The results are reported in Table 3. The signs, magnitudes and significance of coefficients are pretty similar to the ones that we found using region-gender cohorts. Cigarette and coffee demands are consistent with rational addiction (lag and lead consumption coefficients are positive and significant). In the alcohol demand, lag and lead consumptions have negative coefficients. This result might be due to possible inventory effects for alcoholic beverages as we use expenditure data instead of consumption data. In the cigarette demand, current alcohol consumption has a positive and significant coefficient which suggests alcohol is a complement for cigarette. Then we calculated long-run elasticities. When demands are estimated as separate equations, we found that cross price elasticity of cigarette with respect to alcohol price is negative and significant. When demands are estimated as a system, we found that cross price elasticity of alcohol with respect to cigarette price is positive and significant.

Decker and Schwartz (2000) found similar cross price elasticities in an analysis of smoking and drinking participation; i.e. cross price elasticity is negative for cigarette demand while it is positive for alcohol demand. They view this as potential evidence of different behavioral processes determining smoking and drinking behavior:

> "While investigating the underlying behavioral processes determining drinking and smoking decisions is outside the scope of this paper, the measured elasticities are consistent with the following scenario. Increases in beer prices lead some to stop drinking (say, to not go to a bar after work) and as the "situational cue" for social smoking is eliminated, their smoking participation also declines. The effect of cigarette price on drinking participation follows a different scenario. Increases in cigarette prices lead some to quit smoking, inducing greater stress among the now-former smokers who turn to alcohol consumption for its palliative effects." (Decker and Schwartz 2000, p.16)

We agree with the view that cigarettes and alcohol are complements especially in social settings like bars, etc. while they might be substitutes in certain cases where the individual sees both cigarettes and alcohol as stress reducers. On the one hand, drinking works as a trigger for smoking in bars or any social settings; on the other hand, people who cut cigarette consumption might increase alcohol consumption to alleviate resulting stress, which induces an asymmetry in cross price elasticities. The cross price elasticities of coffee is not significant in this specification either.

Conclusion

In this study, using pseudo panel data we analyze the relation between cigarette, alcohol and coffee consumption within rational addiction framework. Our purpose in this study is twofold: to get insights about behavioral processes concerning cigarette, alcohol and coffee consumption; to generalize rational addiction model in order to include three addictive goods. We found that alcohol is a complement for cigarette, while it is not the same the other way around. In addition, we found that alcohol is a gateway for cigarette. We believe that drinking works as a trigger for smoking especially in social setting like bars, etc. On the other hand, it is also possible (although less likely) that individuals who want to cut cigarette consumption might increase alcohol consumption to relieve resulting stress. This scenario is consistent with the observed asymmetry in cross price elasticities.

We did not find any relation between coffee consumption and the consumption of cigarette and alcohol. This does not rule out the possibility that coffee and cigarette are complements for certain people. However there is not a significant complementarity relationship when we look at the whole population. Thus policies regarding smoking such as excise taxes or smoking bans are not likely to have a significant effect on the overall coffee consumption.

However, it is worth to mention that these results are just preliminary, and further analyses are required

Table 1. Estimates of Cigarette, Alcohol and Coffee Demand (region-gender cohorts used)

Cigarettes			***Alcohol***			***Coffee***		
Constant	-101.778	(<.001)	Constant	134.985	(0.403)	Constant	-3.063	(0.891)
C_{t-1}	0.116	(0.100)	A_{t-1}	0.020	(0.761)	K_{t-1}	0.215	(0.002)
C_{t+1}	0.089	(0.207)	A_{t+1}	-0.090	(0.132)	K_{t+1}	0.226	(0.001)
A_{t-1}	0.019	(0.081)	C_{t-1}	-0.106	(0.790)	C_{t-1}	-0.005	(0.903)
A_t	0.011	(0.324)	C_t	0.138	(0.750)	C_t	0.019	(0.660)
A_{t+1}	0.001	(0.888)	C_{t+1}	0.267	(0.506)	C_{t+1}	0.024	(0.552)
K_{t-1}	0.052	(0.666)	K_{t-1}	0.157	(0.822)	A_{t-1}	-0.007	(0.272)
K_t	0.068	(0.591)	K_t	0.915	(0.210)	A_t	0.008	(0.256)
K_{t+1}	-0.082	(0.488)	K_{t+1}	-1.685	(0.013)	A_{t+1}	-0.001	(0.926)
P_{Ct}	-3.749	(0.372)	P_{At}	-160.914	(<.001)	P_{Kt}	-2.983	(0.153)
rincome	-0.008	(0.641)	rincome	0.443	(<.001)	rincome	0.022	(0.039)
fam_size	4.048	(0.070)	fam_size	2.644	(0.836)	fam_size	0.686	(0.587)
perslt18	-5.185	(0.075)	perslt18	20.779	(0.218)	perslt18	-0.967	(0.571)
age_ref	0.028	(0.810)	age_ref	2.586	(<.001)	age_ref	0.040	(0.530)
white	4.606	(0.276)	white	97.910	(<.001)	white	0.691	(0.779)
married	-0.423	(0.945)	married	-112.133	(0.001)	married	1.140	(0.745)
widowed	10.781	(0.192)	widowed	-100.389	(0.035)	widowed	-4.171	(0.390)
divorced	3.989	(0.535)	divorced	-66.249	(0.073)	divorced	-4.372	(0.244)
seperated	8.461	(0.514)	seperated	-88.569	(0.241)	seperated	3.102	(0.683)
college	2.313	(0.544)	college	-35.624	(0.103)	college	-0.942	(0.671)
R^2	0.673		R^2	0.696		R^2	0.770	

Table 2. Long-run Elasticities (region-gender)

	separate		system	
ε_{CC}	-0.557	(0.3562)	-0.302	(0.649)
ε_{AA}	-1.828	(<.001)	-1.901	(<.001)
ε_{KK}	-0.494	(0.149)	-0.667	(0.064)
ε_{CA}	-0.503	(0.130)	-1.074	(0.058)
ε_{CK}	-0.007	(0.907)	-0.010	(0.967)
ε_{AC}	-0.020	(0.721)	0.138	(0.749)
ε_{AK}	0.023	(0.566)	0.018	(0.912)
ε_{KC}	-0.068	(0.621)	1.141	(0.230)
ε_{KA}	-0.064	(0.892)	-0.055	(0.945)
ε_{CY}	0.044	(0.703)	0.048	(0.700)
ε_{AY}	0.352	(<.001)	0.357	(<.001)
ε_{KY}	0.429	(0.020)	0.443	(0.014)

Table 3. Estimates of Cigarette, Alcohol and Coffee Demand (region-birth cohorts used)

Cigarettes			***Alcohol***			***Coffee***		
Constant	-72.455	(<.001)	Constant	137.905	(0.221)	Constant	-12.004	(0.439)
C_{t-1}	0.118	(0.034)	A_{t-1}	-0.088	(0.091)	K_{t-1}	0.244	(<.001)
C_{t+1}	0.099	(0.077)	A_{t+1}	-0.112	(0.031)	K_{t+1}	0.248	(<.001)
A_{t-1}	0.002	(0.778)	C_{t-1}	0.165	(0.613)	C_{t-1}	-0.021	(0.511)
A_t	0.020	(0.029)	C_t	0.654	(0.064)	C_t	0.018	(0.607)
A_{t+1}	0.009	(0.328)	C_{t+1}	-0.032	(0.922)	C_{t+1}	-0.026	(0.421)
K_{t-1}	-0.003	(0.975)	K_{t-1}	0.236	(0.680)	A_{t-1}	-0.001	(0.941)
K_t	0.054	(0.603)	K_t	0.152	(0.806)	A_t	0.001	(0.837)
K_{t+1}	-0.056	(0.577)	K_{t+1}	-0.275	(0.641)	A_{t+1}	-0.001	(0.942)
P_{Ct}	-3.627	(0.316)	P_{At}	-129.425	(<.001)	P_{Kt}	-2.419	(0.213)
rincome	-0.011	(0.524)	rincome	0.516	(<.001)	rincome	0.018	(0.068)
fam_size	5.856	(0.001)	fam_size	19.593	(0.058)	fam_size	-0.696	(0.469)
perslt18	-4.587	(0.021)	perslt18	-5.421	(0.637)	perslt18	0.237	(0.827)
male	-1.536	(0.547)	male	3.288	(0.822)	male	-0.728	(0.610)
white	2.258	(0.497)	white	64.402	(<.001)	white	1.815	(0.328)
married	-0.228	(0.961)	married	-5.142	(0.853)	married	6.558	(0.013)
widowed	2.057	(0.707)	widowed	22.652	(0.482)	widowed	0.952	(0.750)
divorced	7.549	(0.134)	divorced	15.847	(0.601)	divorced	-0.886	(0.756)
seperated	-0.468	(0.959)	seperated	51.826	(0.337)	seperated	1.765	(0.730)
college	-3.106	(0.301)	college	1.057	(0.952)	college	0.927	(0.589)
R^2	0.699		R^2	0.531		R^2	0.747	

Table 4. Long-run Elasticities (region-birth)

	separate		system	
ε_{CC}	-0.554	(0.306)	-0.541	(0.359)
ε_{AA}	-1.336	(<.001)	-1.529	(<.001)
ε_{KK}	-0.437	(0.209)	-0.521	(0.146)
ε_{CA}	-0.363	(0.080)	-0.475	(0.247)
ε_{CK}	0.001	(0.988)	0.166	(0.484)
ε_{AC}	-0.053	(0.405)	0.706	(0.039)
ε_{AK}	-0.003	(0.897)	-0.014	(0.921)
ε_{KC}	0.055	(0.625)	0.879	(0.322)
ε_{KA}	0.024	(0.935)	-0.049	(0.937)
ε_{CY}	0.021	(0.856)	0.011	(0.928)
ε_{AY}	0.390	(<.001)	0.391	(<.001)
ε_{KY}	0.384	(0.043)	0.404	(0.023)

Appendix A: List of demographics variables used

Variable	Variable Definitions
AGE	age of the reference person
MARRIED	1 if the reference person is married
WIDOWED	1 if the reference person is widowed
DIVORCED	1 if the reference person is divorced
SEPERATED	1 if the reference person is seperated
COLLEGE	1 if the reference person has a bachelor's or a higher degree
FAM_SIZE	number of members in CU
PERSLT18	number of children less than 18 in CU

Appendix B: Calculation of Lewbel price indices for alcoholic beverages

Lewbel price indices allow heterogeneity in preferences for goods within a given bundle of goods. Cobb Douglas within bundle preferences are assumed, while between bundles any specification is allowed. Following Lewbel (1989) and Hoderlein and Mihaleva (2008), we construct Lewbel price indices as:

$$v_i = \frac{1}{k_i} \prod_{j=1}^{n_i} \left(\frac{p_{ij}}{w_{ij}}\right)^{w_{ij}}$$

where w_{ij} is the budget share of good j in group i of the household, and p_{ij} is the price index.

k_i is a scaling factor with $k_i = \prod_{j=1}^{n_i} \bar{w}_{ij}^{-\bar{w}_{ij}}$ and $\overline{w}_{ij}$ is the budget share of the reference household.

In our sample there are many zero expenditures reported for subcategories of alcoholic beverages. To deal with that first we took the log, then the exponential of Lewbel price index referring to the fact that $lim \log_{x\to 0} x \log(x) = 0$.

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