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Cigarette, Alcohol, and Drug Demand for Young Population

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The purpose of this paper is to estimate demand elasticities of cigarette, alcohol, and cocaine for a sample of young American population. To deal with the inherent censoring issue in cigarette, alcohol, and drug consumption data, the paper applies ZINB, Tobit, and a two-step AIDS model. Findings indicate habit formation in young American consumption. Also, the results show that alcohol has an inelastic income elasticity. The ZINB model price elasticity, Marshallian own price elasticity, and Hicksian own price elasticity all agree that drug has a negative inelastic own price elasticity. This implies that price increased by drug traders increases their total revenue and slightly affects the quantity demanded of drug.

Keywords: *Alcohol demand, Drug demand, Cigarette demand, Demand, Censored Data*

JEL Classification: *D04, D12, R22*

1. Introduction

Estimating demand own price elasticity of cigarette, alcohol, and the drug is critical because it can inform decision makers on how responsive is the quantity demanded to changes in price. Cross-price elasticities can also give the decision makers more details about the association between cigarette, alcohol, and drug. This leads to the classification of these goods according to their consumption as a complement, substitute, or independent. Thus, a preventive plan to eliminate or at least reduce cigarette, alcohol, and drug consumption can be designed.

This paper aims to estimate demand elasticities of cigarette, alcohol, and drug. Also, the impact of socio-economic variables, such as race and gender, on tobacco and intoxicants consumption will be investigated. This paper focuses on youth population since young population usually have different consumption habits compared with adult population.

2. Literature Review

Saffer and Chaloupka (1999) estimated the average alcohol price elasticity to be -0.30. The authors concluded that alcohol and illicit drug are complements. Farrelly et al. (2001) examined the demand for cigarettes and marijuana on a sample of the young population aged 12 to 20 years. The authors found a

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complementary relationship between marijuana and cigarettes. Sheu et al. (2004) used a zero-inflated negative binomial (ZINB) regression to estimate the impact of tax and socio-economic variables on tobacco consumption in California. The estimated own-price elasticity is -0.46. The authors found that price policy alone may not be an effective policy to make frequent smokers to quit smoking. However, it may reduce tobacco consumption. For occasional smokers, especially teenagers, price does not affect their smoking decision to quit smoking. Goel (2009) concluded that cigarette and drug are substitutes and higher income increases drug consumption. Herzfeld et al. (2014) examined the impact of individuals and socio-economic variables on fat, protein, alcohol, and cigarette use in Russia. The results showed that regional macroeconomics characteristics and lagged level of consumption had a significant impact on fat, food diversity, alcohol, and cigarette consumption. Estimated own price elasticity of alcohol and cigarette were inelastic and ranged from -0.07 to -0.22.

Contrary to studies that estimated cigarette and alcoholic consumption as a single equation, Su and Yen (2000) estimated the U.S. cigarette and alcoholic consumption as a system of equations. To handle the issue of censoring, they used two-step estimation procedures based on probit and maximum likelihood estimator. They obtained a negative income elasticity for the cigarette and a positive income elasticity of alcohol. According to their findings, the cigarette is considered as an inferior product. Thus, a one percent increase in income decreases cigarette consumption by 0.12 percent but increases alcohol consumption by 0.44 percent. Yen (2005) studied the US demand for cigarette, beer, and wine. The author concluded that demographic variables are crucial determinants of cigarette, beer, and wine consumption. Also, the author stated that income does not play a major role in the consumption of cigarette, beer, and wine. Pan et al. (2006) estimated Chinese alcoholic demand using a two-step estimation approach to tackling censored data problem. In the first step, they examined whether a person consumes alcohol or not using a probit model. In the second phase, they used the CDF and PDF from the first step to estimate the AIDS model. The estimated own Marshallian price elasticities for the different alcoholic beverage types ranged from 0.58 to -1.89. Hicksian own price elasticities ranged from 0.75 to -1.86. Income elasticities ranged from 0.51 to 1.39. Thus, the study concluded that wine is considered luxury goods for Chinese consumers and beer is a normal good. Gallet (2014) has empirically evaluated the literature on the price elasticity of illicit drugs using meta-regression approach. The author concluded that the functional form of demand, specification problems, type of data, methodology, and journal quality have less effect on the price elasticity estimate.

Golan et al (2001) Estimated an almost ideal demand system (AIDS) for beef, pork, chicken, processed meat, and fish in Mexico. The data was a censored cross-sectional data because many of the surveyed households did not consume specific types of meat. To deal with censored data issue, they used a generalized maximum entropy method to estimate the AIDS model. (Weliwita et al., 2003; Caracciolo and Cembalo, 2010, Singh et al., 2014)used a two-step estimation techniques to deal with zero observations. The first step involves estimating a probit regression model. In the second step, the parameters of the probit model are used to compute the inverse Mill's ratios. Then the inverse Mill's ratios are used in estimating the AIDS model using a nonlinear iterative seemingly unrelated regression model.

What makes this paper a good contribution to the existing literature is that it is the first paper that tries to estimate cigarette, alcohol, and cocaine demand for the young population using both the ZINB and the linear AIDS model. This is important because an individual may consume tobacco, alcohol, and drugs. Ignoring any of these variables may give misleading cross-price elasticities, especially if the person consumes all of them. Also, this paper will try to compare estimates based on an ad-hoc model that is estimated as a single equation with a theory based model that is estimated as a system of equations using the linear AIDS model.

3. Theory and Empirical Model

The microeconomic theory states that the demand for a commodity is a function of its own price, cross-price of compliments and substitutes goods, individual income, and personal preferences. To estimate demand of cigarette and intoxicant, this study will develop three models. The reason for developing three models is because many households do not consume cigarette or intoxicant. Also, there are many of the surveyed household escaped or did not answer the question about alcohol and drug consumption. Thus, this will cause the data to be censored from below or left censoring (excessive zero observations).

The first model is an ad-hoc model that is estimated separately as a single equation. The model has specified similarly to Herzfeld et al. (2014) specification.

$$q_{it} = q_{i,t-1} + \beta X'_{it} + \gamma M'_{kt} + u_{it} \quad (1)$$

Where q_i is the quantity consumed of product i, $q_{i,t-1}$ is a one period lagged quantity consumed of product i. A positive sign of this coefficient indicates an increasing effect of lagged consumption on current

consumption, which the authors defined as habit formation. On the other hand, a negative coefficient means decreasing the effect of past consumption on current consumption, and the authors defined it as accumulation effect.

X'_{it} is a vector of socioeconomic variables such as age, gender, and personal income in logarithmic form. M'_{kt} is a vector of own price and cross price of goods. u_{it} is the error term.

Since the dependent variable, in this case, is a count variable (the number of times a person drinks or smokes a cigarette), the first model is estimated using a count dependent variable estimation technique such as Poisson regression or negative binomial regression.

The second model consists of two-step estimation approach. The first step involves determining whether the individual consumes tobacco, alcohol, and drug. This is accomplished by using probit model. The Probit model takes the following form:

$$P_{ih} = f(P_1, \dots, P_J, X, D_1, \dots, D_J) \quad (2)$$

where P_{ih} is one if the individual consumes cigarette, drug or alcohol. Furthermore, it is zero if he/ she does not consume cigarette and intoxicants. Then based on the probit model parameters, I construct the inverse Mill's ratio for each household. The inverse Mill's ratio for the household who consumes cigarette or intoxicant is:

$$\Phi_i = \frac{\phi(P_1,\dots,P_J,X,D_1,\dots,D_J)}{\theta(P_1,\dots,P_J,X,D_1,\dots,D_J)} \quad (3)$$

Where ϕ and θ are the CDF and PDF, respectively. On the other hand, the inverse Mill's ratio for individual who does not consume cigarette or intoxicant is:

$$\Phi_i = \frac{\phi(P_1,\dots,P_J,X,D_1,\dots,D_J)}{1-\theta(P_1,\dots,P_J,X,D_1,\dots,D_J)} \quad (4)$$

Then the inverse Mill's ratios of the censored endogenous variables are used in the second step to estimate the AIDS model. Thus, the AIDS model that will be estimated in the second step takes the following form similar to the model estimated by Pan et al. (2006):

$$W_i = \Phi(Z'_i\hat{a_1})\left\{\alpha_{i0} + \sum_{j=1}^{n}\gamma_{ij}\ln P_j + \beta_i \ln\left(\frac{Y_t}{P^*}\right) + \gamma_i D_i\right\} + \delta_i\Phi(Z'_i\hat{a_1}) + \varepsilon_i \quad (5)$$

Where W_i is the budget share for cigarette, alcohol, and drug; Y is the total expenditures on cigarette and intoxicants; P^* is the stone price index defined as $\ln P^* = \sum W_k \ln P_k$; P_j denotes cigarette and intoxicants price; D_i is a vector of demographic variables, and ε_i is the disturbance term. The final model (5) is estimated using the iterative seemingly unrelated regression method (ITSUR). For the linear AIDS model to be consistent with micro theory, symmetry and homogeneity restrictions are imposed in the estimation (Deaton and Muellbauer, 1980).

The expenditure elasticities of the two-step model are calculated as:

$$\varepsilon_i = 1 + \frac{\Phi(Z'_i\alpha_i)\beta_i}{W_i} \quad (6)$$

To minimize error in calculating price elasticities, Green and Alston (1990) suggested the following formula:

$$\varepsilon_{ij} = \frac{d\ln q_i}{d\ln p_j} = -\theta_{ij} + \frac{d\ln W_i}{d\ln p_j} = \Phi(Z'\alpha_i)\left(\frac{\gamma_{ij}}{W_i} - \frac{\beta_i W_j}{W_i}\right) - \delta_i(Z'_i\alpha_i)\Phi(Z'_i\alpha_i)\alpha_{ij} - \theta_{ij} + \left\{\beta_{i0} + \sum_{j=1}^{n}\gamma_{ij}\ln P_{jt} + \beta_i\ln\left(\frac{Y_t}{P^{*}*}\right) + \gamma_i D_{it}\right\} * \Phi(Z'_i\alpha_i)\alpha_{ij} \quad (7)$$

Where θ_{ij} is the Kronecker delta that equals 1 for $i = j$ and 0 otherwise. I use Slutsky equation to get Hicksian elasticities as below:

$$\varepsilon_{ij}^{h} = \varepsilon_{ij} + w_j\varepsilon_i \quad (8)$$

In the third model, I estimate the linear AIDS model using a censored Tobit regression. The estimated Tobit model is expressed as:

$$W_i = \alpha_i + \sum_{j=1}^{n}\gamma_{ij}\ln P_j + \beta_i\ln\left(\frac{Y_t}{P^*}\right) + \gamma_i D_i + \varepsilon_i \quad (9)$$

The equations were estimated jointly as a system of equation with symmetry and homogeneity restrictions imposed in the estimation. I will follow the convention in the literature in calculating income and price elasticity of demand. Thus, the expenditure elasticity will be calculated as follow:

$$\varepsilon_i = 1 + \frac{\beta_i}{W_i} \quad (10)$$

Marshallian own price elasticity is calculated as below:

$$\varepsilon_{ii} = -1 + \frac{\gamma_{ii}}{W_i} - \beta_i \quad (11)$$

Marshallian cross price elasticity is calculated as follow:

$$\varepsilon_{ij} = \frac{\gamma_{ij} - w_j\beta_i}{wi} \quad (12)$$

Hicksian elasticity for the third model is calculated using equation 8.

The fourth model is the same as the second model without the interaction term. Thus, the fourth model is expressed as:

$$W_i = \alpha_{i0} + \sum_{j=1}^{n} \gamma_{ij} \ln P_j + \beta_i \ln\left(\frac{Y_t}{P^*}\right) + \gamma_i D_i + \delta_i \Phi(Z'_i \hat{a}_i) + \varepsilon_i \quad (13)$$

The income and price elasticities for this model are calculated using equations (10), (11), and (12), respectively.

4. Data

The data for alcohol, cigarette and drug consumption come from the national longitudinal survey of the youth NLSY using mainly 1999 cohort. For the first model, I use 1999 and 2000 cohort, respectively. Therefore, the data are primarily cross-sectional data. For drug consumption, I will consider cocaine use as a representative for drug consumption. Cigarette and alcohol prices come from the U.S. Bureau of Labor Statistics. Cocaine prices come from Drug Enforcement Administration. Furthermore, all prices were mean scaled following demand literature. Williams et al. (2006) mentioned that price data for the drug is based on convenience samples and has limited variability concerning geography and time. The main disadvantage of this paper is that the prices used in the estimation are proxy to the real prices. Thus, they may not approximate the actual prices paid by the surveyed respondents.

5. Estimation Procedures and Results

Table 1 shows basic descriptive statistics about the key variables of the study. The reason for the zero observations in cigarette, alcohol, and cocaine consumption is that the surveyed household does not consume them, escaped to answer the question, or refused to respond to the question. The minimum and maximum quantities of alcohol, cigarette, and cocaine in 1999 and 2000 are the same. The highest amount of consumed cigarette, alcohol, and cocaine is 40, 99, and 500, respectively. Age, female, GPA, income and depression are for 1999 cohort.

Table 1. *Key variables descriptive statistics*

Variable	N	Mean	Std Dev	Min	Max
Cigarette consumption 1999	8984	1.96	5.40	0	60
Cigarette consumption 2000	8984	2.32	5.86	0	60
Alcohol consumption 1999	8984	1.87	5.00	0	99
Alcohol consumption 2000	8984	2.18	5.79	0	99
Cocaine consumption 1999	8984	1.53	19.28	0	500
Cocaine consumption 2000	8984	2.37	25.83	0	500
Age	8984	18	1.40	16	20
Female	8984	0.49	0.50	0	1
GPA	8984	7.79	21.42	0	100
Income	8984	2065.30	4524.31	0	30623
Depression	8984	3.17	1.27	0	4

The average age of respondent is 18 years, average GPA is almost 8, and average income is $2065. The highest respondent earns $30623. Depression is measured as the number of times the respondent was depressed. The average depression cases reached 3 cases.

As was mentioned in section 3 that the first model needs to be estimated using a count variable method. This is attributed to the nature of the dependent variable, which indicates the number of times a person smokes, drinks, or abused drug. To evaluate whether it is possible to use Poisson model, it is important to examine the distribution of the dependent variable. This is due to the restrictive properties of the Poisson distribution, which states that the conditional mean has to equal the variance.

Table 2. *Unconditional mean and variance*

Variable	Mean	Variance
Number of times a person does cocaine	2.3674310	666.9929990
Number of times a person drinks Alcohol	2.1769813	33.5489925
Number of times a person smokes cigarette	2.3219056	34.2997939

As shown in Table 2 that the variance does not equal the mean. Thus, it does not meet the Poisson distribution properties, and Poisson distribution should not be used in the estimation. Furthermore, the frequency distribution of the data shows that 94 percent of cocaine observations, 72 percent of cigarette observations, and 60 percent of alcohol observations are zeros. Due to the excessive number of zeros and the nature of the dependent variable, the best model to use is to estimate equation (1) using the zero-inflated negative binomial (ZINB) model. Table 3 shows the estimated coefficients of the ZINB model, except price and income parameters that will be reported later for comparison purposes with the second and the third model.

Table 3. *ZINB model parameter estimates*

	Cigarette	**Alcohol**	**Cocaine**
Intercept	3.100*** (0.718)	2.981*** (0.391)	3.306 (2.665)
$\mathbf{q_{i,t-1}}$	0.176*** (0.010)	0.091*** (0.008)	0.102*** (0.034)
Sex	-0.388*** (0.076)	-0.497*** (0.050)	-0.710** (0.284)
Depression	-0.291*** (0.057)	-0.194*** (0.036)	-1.204*** (0.215)
Age	-0.144*** (0.040)	-0.102*** (0.023)	0.009 (0.152)
GPA	-0.001 (0.002)	0.001 (0.001)	0.000 (0.006)

Note: ***, **, * significant at the 1%, 5%, and 10% level. standard errors are in parentheses.

The coefficient of the one period lagged dependent variable for cigarette, alcohol, and cocaine has a positive sign. This indicates an increasing effect of previous consumption on current consumption, which is interpreted as habit formation (Herzfeld et al., 2014) in cigarette, alcohol, and cocaine consumption.

For the second model, I first estimate the probit model. In the second step, I use the inverse Mill's ratio for the censored dependent variable to estimate equation (5) using ITSUR method. Furthermore, I impose symmetry and homogeneity restrictions in the estimation. To avoid singularity in the variance-covariance matrix, I estimate the system of equations with cocaine equation dropped. Then I use microeconomic theory restrictions to recover the parameter of the dropped equation. Table 4 and Table 5 show the estimated coefficients of the probit and the ITSUR, respectively.

Table 4. *Estimated coefficients of the probit model*

	Cigarette	**Alcohol**	**Cocaine**
Intercept	-3.150*** (0.197)	-3.500*** (0.186)	-2.824*** (0.304)
Female	-0.028 (0.029)	-0.041 (0.027)	-0.003 (0.045)
Depression	0.056*** (0.012)	0.115*** (0.011)	0.023 (0.018)
Age	0.130*** (0.010)	0.155*** (0.010)	0.061*** (0.016)

Note: ***, **, * significant at the one, five, and ten percent level, respectively; standard errors are in parentheses.

Table 5. *Iterative seemingly unrelated regression model (ITSUR) parameters*

Equation	(8)	(13)
α_1	-0.669 (0.511)	-1.356*** (0.509)
α_2	0.937*** (0.189)	2.325*** (0.189)
γ_{11}	0.317* (0.163)	0.475*** (0.176)
γ_{12}	-0.312* (0.163)	-0.470*** (0.176)
γ_{13}	-0.005 (0.003)	-0.005 (0.004)
γ_{22}	0.321**	0.480***

	(0.163)	(0.177)
γ_{23}	-0.009** (0.004)	-0.010*** (0.004)
β_1	0.087*** (0.003)	0.117*** (0.004)
β_2	-0.180*** (0.004)	-0.192*** (0.004)
$\mathrm{IMR}_{\mathbf{1}}$	-1.023*** (0.215)	-0.317 (0.213)
IMR_2	1.524*** (0.222)	0.232 (0.218)
$\mathrm{Sex}_{\mathbf{1}}$	0.026** (0.012)	0.028** (0.012)
$\mathrm{Sex}_{\mathbf{2}}$	-0.058*** (0.012)	-0.059*** (0.011)
$\mathrm{Depression}_{\mathbf{1}}$	0.021 (0.012)	0.016 (0.014)
$\mathrm{Depression}_2$	-0.025* (0.014)	-0.024* (0.014)
$\mathrm{Age}_{\mathbf{1}}$	0.066** (0.032)	0.055* (0.032)
$\mathrm{Age}_{\mathbf{2}}$	-0.030*** (0.020)	-0.031 (0.020)

Note: ***, **, * significant at the one, five, and ten percent level, respectively; standard errors are in parentheses.

The probit model shows that older respondents are more likely to consume tobacco and intoxicants compared with younger respondents. Depressed people are more likely to smoke a cigarette and drink alcohol compared to non-depressed respondents.

The third model involves estimating the standard AIDS model using the censored Tobit model. This is accomplished by setting zero as the lower bound value. Then the system of demand equations is jointly estimated with cocaine equation dropped to avoid the singularity in the variance-covariance matrix. Moreover, to make the estimation consistent with demand theory, I imposed symmetry and homogeneity restrictions in the estimation. Table 6 shows parameter estimates of the Tobit model.

Table 6. *Tobit parameter estimates*

Parameter Estimates	**Values**
α_1	-0.981*** (0.121)
α_2	1.583*** (0.084)
γ_{11}	0.475** (0.193)
γ_{12}	-0.465** (0.193)
γ_{13}	-0.010* (0.006)
γ_{22}	0.476** (0.194)
γ_{23}	-0.011** (0.004)
β_1	0.189*** (0.006)
β_2	-0.197*** (0.004)
$\mathrm{Sigma}_{\mathbf{1}}$	0.508*** (0.007)
Sigma_2	0.366*** (0.004)
$\mathrm{Sex}_{\mathbf{1}}$	0.074*** (0.017)

Sex_2	-0.075*** (0.012)
$Depression_1$	0.012 (0.008)
$Depression_2$	0.010* (0.005)
Age_1	-0.006** (0.006)
Age_2	0.018*** (0.004)

Note: ***, **, * significant at the one, five, and ten percent level, respectively; standard errors are in parentheses.

Table 7. *Income and expenditure elasticities evaluated at the mean*

	Average Share	**ZINB**	**2-step Model equation (8)**	**2-step Model equation(13)**	**Tobit**
Cigarette	0.41	0.13	1.27	1.29	1.46
Alcohol	0.53	0.11	0.64	0.64	0.63
Drug	0.06	0.17	4.08	2.20	1.12

Table 7 compares the estimated expenditures elasticities using the two-step model, Tobit model, and the ZINB model. It can be seen that the two-step models as represented in equation (8) and (13) are similar in values. The ZINB model has underestimated the income elasticities compared with the theory-based models. Both the Tobit and the two-step models show that cigarette and drug are income elastic. A one percent increase in cigarette smokers' income increases his/her cigarette smoking by more than one percent. Moreover, a one percent increase in drug abusers' income increases his/her drug consumption by 1.12 percent and 4.08 percent as suggested by the Tobit and the tow step model, respectively. Surprisingly, both models viewed cigarette and drug as a luxury good. Furthermore, as proposed by the Tobit and the two-step model, alcohol is found to be income inelastic and considered as a normal good for the surveyed young population. Thus, a one percent increase in alcohol drinkers' income increases their alcohol consumption by 0.6 percent. On the other hand, ZINB model indicates that cigarette, alcohol, and drug are income inelastic and considered as normal goods. Similarly, Table 8 shows Marshallian price elasticities of the two-step (using equation 8 and 13) and the Tobit model, respectively. All the estimated own price and cross price elasticities using both models are price inelastic, except the cross price elasticity of cigarette for drug consumption using the two-step model.

Table 8. *Marshallian price elasticities evaluated at the mean*

	Two-step model equation 8 Two-step model equation (13)			**Tobit**		
	Cigarette	**Alcohol**	**Drug**	**Cigarette**	**Alcohol**	**Drug**
Cigarette	-0.013	-0.785	0.080	-0.031	-0.708	-0.039
	(0.040)	(-0.621)	(-0.023)			
Alcohol	-0.607	-0.656	-0.162	-0.312	0.099	0.013
	(-0.320)	(0.102)	(0.013)			
Drug	-1.057	-0.956	-0.623	-0.061	-0.075	-0.674
	(-0.496)	(-0.641)	(-0.841)			

Note: Elasticities in parentheses are for the two-step model in equation (13)

All the own price elasticities for the two-step model estimated using equation 8 have a negative sign. Also, all the own price elasticities of the Tobit model have a negative sign, except the own price elasticity of alcohol. Both the two-step model estimated using equation 8 and the Tobit model indicate that alcohol is a complement good in the cigarette and drug consumption. Furthermore, cigarette is a complement good in alcohol and drug consumption in both models. In the two-step model (equation 8), Drug is a substitute good in tobacco consumption and a complement good in alcohol consumption. Conversely, in the Tobit model drug is a complement good in cigarette consumption and a substitute good in alcohol consumption. The economic literature suggests that Marshallian elasticities are used for policy analysis. However, Hicksian elasticities give a more precise measure of the relationship between goods. Table 9 shows Hicksian and the ZINB model price elasticities.

Table 9. *Hicksian price elasticities evaluated at the mean compared with ZINB elasticities*

	Two-step model equation 8 Two-step model equation (13)			**Tobit**			**ZINB**		
	Cigarette	**Alcohol**	**Drug**	**Cigarette**	**Alcohol**	**Drug**	**Cigarette**	**Alcohol**	**Drug**
Cigarette	0.507	-0.116	0.160	0.490	-0.039	0.040	2.378	-3.217	-0.019
	(0.568)	(0.057)	(0.058)						
Alcohol	-0.343	-0.316	-0.121	-0.047	0.439	0.053	1.463	-15.795	0.019
	(-0.060)	(0.437)	(0.053)						
Drug	0.615	1.194	-0.368	1.611	2.075	-0.419	4.886	-12.648	-0.167
	(0.405)	(0.518)	(-0.703)						

All the estimated model indicate that Hicksian own price elasticities of cigarette have an upward sloping demand curve. However, the ZINB model has overestimated the own price elasticity of alcohol compared with either the Marshallian or Hicksian price elasticities of the theory-based models. The ZINB model has overestimated the own and cross price elasticities compared with either the Marshallian or Hicksian elasticities. Thus, the discussion of cross-price elasticities will be concentrated on those elasticities estimated by the Tobit and two-step method using equation (8). On the other hand, all the estimated own-price elasticity of drug shows that drug is price inelastic. This has a significant policy implication. It implies that increases in drug prices have a small percentage decrease in the quantity demanded of the drug. This allows drug traders to exploit their victims and maximize their returns. This is because price increase for an inelastic demand increases total revenue.

The Hicksian cross-price elasticities of the two-step model (equation 8) match in sign with the Marshallian elasticities, except the cross-price elasticities of alcohol with drug consumption and the cross-price elasticity of cigarette with drug consumption. Tobit model and the two-step model (equation 8) suggest through the Hicksian cross-price elasticities that cigarette and alcohol are both considered as substitutes for the drug by drug abusers. By comparing Marshallian and Hicksian cross price elasticities, it can be said that both alcohol and cigarette are gross complements but a net substitute for drug consumption. Moreover, the Marshallian cross-price elasticities as estimated by the Tobit model show that drug is a gross complement in cigarette consumption, but the drug is a net substitute in cigarette consumption as indicated by the Hicksian cross-price elasticities.

6. Conclusion

The paper examines young American demand of cigarette, alcohol, and drug. The data is censored from below with excess zero observations. This is because many of the surveyed households did not consume cigarette, alcohol, and drug. Also, it is because the respondents refused or escaped to answer the question about their cigarette and intoxicants consumption. The paper developed three models to deal with data censoring issue. The first model is a dynamic ad-hoc model that was estimated using the ZINB model. The model shows an increasing effect of previous consumption of cigarette, alcohol, and drug on current consumption. This indicates habit formation in cigarette and intoxicants consumption. The second model is the linear AIDS model estimated in two-step techniques. The third model estimates the system of the linear AIDS demand equations simultaneously using a censored Tobit model. The ZINB model, in general, has underestimated income elasticities and overestimated own and cross-price elasticities compared with the theory-based models. All the estimated Marshallian own price elasticities of the two-step models are price inelastic, indicating price alone does not have a strong influence on young population cigarette and intoxicants consumption. The Marshallian and the Hicksian cross-price elasticities of the two-step model estimated using equation (8) showed that drug is a substitute and alcohol is a complement in cigarette consumption. Also, drug and cigarette are complements in alcohol consumption. However, alcohol and cigarette are gross complements in drug consumption as indicated by the Marshallian elasticities, but net substitute in drug consumption as reported by the Hicksian cross-price elasticities. The Tobit model's Marshallian and Hicksian cross-price elasticities showed that cigarette smokers consider alcohol as a complement to the cigarette. Also, the model displays that drug is considered as a substitute and cigarette as a complement to alcohol by alcohol drinkers. Furthermore, according to the estimated cross-price elasticities of the Tobit model, drug is gross complement but net substitute in cigarette consumption. Alcohol and cigarette both are gross complement but net substitute in drug consumption. The estimated expenditures elasticities by the theory based models show that both cigarette and drug are income elastic, indicating that they are luxury goods for young American. On the other hand, alcohol is income inelastic indicating that alcohol is a normal good for young American. The estimated own-price elasticity of cocaine using the three models developed in this paper showed that cocaine has an inelastic own

price elasticity. The paper concluded that the inelastic demand allows cocaine traders to increase their total revenue by increasing cocaine price. This gives them the opportunity to exploit their victims and maintain a small percentage change in the quantity demanded of cocaine.

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