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Department of Economics
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Frequency and intensity of alcohol consumption: New Evidence from Sweden

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Abstract

This paper provides an extensive analysis of the demand for alcohol in terms of total quantity and quantity subdivided into frequency and intensity demand. The analysis compares across alcohol types (beer, wine and spirits), alcohol drinking pattern (average drinker vs. binge drinkers) and also how these decisions differ across gender. The analysis is based on a large sample of cross-sectional data from Sweden 2004-11. The results show a positive socioeconomic (income and education) gradient in quantity. This gradient is generally positive in the frequency decision while negative in the intensity decision. Women predominantly choose to drink wine and show a strong positive socioeconomic gradient in both frequency and intensity demand for wine. Binge drinkers show less of a differentiation across alcohol types and this is true even of binge drinking women. Smoking is universally positively associated with quantity, frequency and intensity of alcohol demand with the exception of wine binge drinkers. The results highlight that while quantity consumed has a positive socioeconomic gradient, policies targeted at the less affluent and less educated are likely to have the greatest impact in reducing the social cost of alcohol and in reducing the socioeconomic gradient in health and socioeconomic related health inequality.

1. Introduction

The demand for alcohol is not just of interest in its own right, but also because alcohol consumption has important and significant societal costs through adverse effects on crime and health for example (Jarl et al., 2008). However, how alcohol influences health and productivity (amongst others) is more complicated than just the total quantity demanded per capita. The frequency of alcohol consumption and the intensity in which alcohol is drunk have differential effects. Those who have a small drink everyday are likely to have less injuries and car accidents than those who drink the same quantity over a set period but binge drink for instance. Evidence from the USA suggests that binge drinkers are 14 times more likely to drink drive compared with non-binge drinkers (Naimi et al., 2003), for example. Evidence from Sweden, noting that binge drinkers are more likely to be heavy drinkers, found that “at least for health care costs, the cost is quite heavily concentrated in the heaviest drinking group” (Jarl et al., 2008). Understanding how frequency and intensity decisions affect the overall quantity decision will allow greater understanding as to what influences an individual’s drinking behaviour. A policy may have no effect on total quantity for example, but may have an effect on the frequency and intensity decisions that would be masked by solely assessing the quantity decision.

The economic literature on alcohol has generally focused on modelling the quantity of alcohol demanded. A few studies have examined the determinants of frequency of consumption specifically for binge drinkers (Manning et al., 1995, Chaloupka and Wechsler, 1996). Even fewer studies have examined both the frequency and intensity decisions together. Berggren and Sutton (1999) estimate a structural model of alcohol

demand where frequency and intensity enter the budget constraint as a multiplicative term. The results show that for spirit consumption in Sweden, frequency and intensity are indeed simultaneous sub-decisions of the overall quantity decision and that education and income are negatively associated with intensity but had no effect on frequency. Petrie et al. (2009) consider an alternate form of the problem, examining the determinants of the intensity frequency ratio. Rather than modelling the budget constraint as Berggren and Sutton (1999), Petrie et al. (2009) define a multiplicative quadratic utility function. The results in Petrie et al. (2009) are consistent with Berggren and Sutton (1999) in that they find a negative relation of the intensity frequency ratio with education. A consequence of the assumed form of the utility function the authors made is that the intensity frequency ratio is related to neither price changes nor income differences. Given the importance of the budget constraint in defining an individual's choice set it is undesirable to assume a utility function that yields this result.

Whilst the research by Berggren and Sutton (1999) was pioneering in breaking apart the quantity decision into its constituent parts of frequency and intensity some empirical issues remained. Prices of alcohol were not included (because the data had no time element), which may be a key component of any demand analysis. The data requirements are also quite demanding when estimating, as the authors did, a structural model that accounts for sample selection. A structural model for frequency and intensity controlling for sample selection requires instruments for frequency and for intensity and an exclusion restriction. However the choice of exclusion restriction and instruments in (Berggren and Sutton, 1999) are debatable. *A priori* it is quite hard to think of many variables that predict the alcohol participation decision but not the

alcohol quantity decision (the exclusion restriction problem), let alone find instruments for frequency and intensity when so little is known about how these decisions are made.

The literature on the demand for frequency and intensity of alcohol consumption is fairly scarce even though it has been shown to be important to consider both frequency and intensity separately as they are important individual decisions. The current paper addresses this evidence gap by utilising new data from Sweden that allows the consideration of the frequency and intensity decisions across three particular alcohol types: beer, wine and spirits. Importantly this new data also allows the frequency and intensity decisions to be compared between all of those who drink and the subset who are binge drinkers giving new insight into the binge drinking decision. The point of departure is the model of Berggren and Sutton (1999). However, the empirical strategy of this paper employs justifiable parametric assumptions to identify the sample selection correction procedure and focus is paid to the reduced form equations that require no debateable instrumental variables to identify the model.

The paper unfolds as follows: Section 2 presents the data material and the estimation strategy, section 3 reports the results and section 4 discusses the results and concludes.

2. Data and Methods

2.1 Data material

Monitor project survey description

Individual level micro-data on individuals' drinking patterns and background characteristics was collected as part of the Monitor project. This is a repeated cross-sectional survey performed by telephone interviews.

A drinker is defined as someone who had an alcoholic drink in the last 30 days before interview. A binge drinker as defined by the Monitor project study is someone who in the last 30 days has had one or more episodes where the quantity of alcohol drank was at least: 1 bottle of wine (75cl), 5 shots of spirit (25cl), 4 cans of strong beer/cider (>3.5%) or 6 cans of low alcohol content beer (3.5%). The same values are used for men and women. The quantities have been converted into centilitres of pure alcohol to allow easier comparability across alcohol types by multiplying in litre terms: beer by 4.62%, wine by 12.8% and spirits by 38%¹.

The data for the period September 2004 through to December 2011 and consists of a total of 144,170 observations. There are subsequently 6,555 missing observations for alcohol consumption patterns, an additional 8,113 missing observations for income, 23,689 missing observations for smoking and 2,152 missing for economic status and 60 missing observations for age. The final sample size is 103,601. Regression analysis is used to assess potential non-response bias (results not shown). Missing values regarding alcohol are strongly negatively linked to age with all other variables seemingly unimportant². Of the explanatory variables, it appears that individuals less likely to answer the income question were less likely to be employed and had a lower level of education (hinting that lower income individuals did not answer). Individuals

¹ Standard measures are taken from: <http://www.can.se/sv/drogfakta/fragor-och-svar/alkohol/> and converted to %vol measures (1cl pure alcohol is 7.8grams of alcohol).

² We define important as both statistically significant at the 1% level and a coefficient effect size of at least 2%

who did not answer the economic status question had lower income yet were more educated. Missing values for smoking are linked to individuals with higher income levels, older individuals and those out of work. It is important to note that, although there is evidence of bias in our data, we assume observations are missing at random in our analysis. The interpretation however will have to be in light of the fact that income affects will be for a subpopulation that is more educated and more likely to be employed, and smoking effects will be for a subpopulation with lower income, younger and more likely to be employed.

The response rate in the period 2004-2011 fell from about 60% to roughly between 35% and 45% towards the end of the study period. Analysis of the response rate found no systematic bias as a result of this fall in response. A standard problem with surveys regarding alcohol is the lower response rate of heavy and or binge drinkers and the resulting bias in alcohol consumption estimates (Meiklejohn et al., 2012). This survey is no exception in this regard as no compensation for this known effect was made. Summary statistics for all variables are shown in **Table I**.

[Insert table I about here]

[Insert figure I about here]

Aggregate national price indexes

Alcohol national price indexes for wine, spirits and beer (shown in **Figure 1**) are provided by Statistics Sweden (Statistiska Centralbyrån). These price indexes are monthly and have been deflated by the CPI index (from Statistics Sweden) so that the index is in 2011 prices. There is no overall price trend for beer but wine and spirits

have seen a fall in real prices over the 7-year period. There is a strong correlation between wine and spirit prices (correlation coefficient of 0.88) and a moderate correlation between beer and wine (0.56) and beer and spirits (0.6).

2.2 Methods

Quantity of alcohol consumed

The starting point is a demand function in double log form (for ease of notation we omit the subscripts for the k types of alcohol):

$$(1) \quad \ln(Q_i) = \ln X_i' \beta + v_i,$$

where $\ln(Q_i)$ is natural log of quantity of alcohol type k consumed by individual i .

where $\ln X_i$ includes a column of 1s, prices (p_j) are included for all k types of alcohol (beer, wine, spirits) along with net monthly income (y_i) and individual characteristics that also affect the alcohol consumption decision.

The advantage of the log-log demand equation is that interpretation is relatively straightforward: the coefficient corresponding to price in the vector β for example is a price elasticity: a 1% change in price leads to a $\beta\%$ change in quantity consumed. The log-log model of demand is limiting in that the model requires the elasticities to be unitary otherwise the expenditures will not be equal to total outlay (i.e. the budget will not add up) unless analysis is within a restricted range of total outlay (Deaton and Muellbauer, 1980). However, less restrictive models require data on budget shares, which are not available. It is therefore assumed that alcohol expenditure does indeed

vary within a restricted range of total outlay, a not too restrictive assumption for the large majority of alcohol consumers. This assumption is likely to be restrictive for heavy drinkers who have very low income and low living costs.

Frequency and intensity

Frequency is defined as the total number of days in which an individual drank in the last 30 days; intensity is defined as the average quantity drunk across all drinking sessions in the last 30 days ($I_i = \frac{Q_i}{F_i}$). The multiplication of frequency and intensity therefore equals the total quantity consumed in the last 30 days yielding:

$$(2) \quad \ln (F_i \cdot I_i) = X_i' \beta + v_i$$

where F is the frequency in which alcohol is drunk and I is the average quantity or intensity in which alcohol is drunk. The data therefore necessitates that frequency and intensity enter the budget constraint as a multiplicative term, which is desirable as it rules out impossible allocations of frequency and intensity such as frequency greater than zero and intensity equal to zero when quantity is greater than zero. Rearranging equation (3) for frequency and intensity separately yields the following two equations (now dropping the subscripts for individuals, i):

$$(3) \quad \ln I = X' \beta_I + \gamma_I \ln F + v_I$$

$$(4) \quad \ln F = X' \beta_F + \gamma_F \ln I + v_F$$

Where $\ln F$ and $\ln I$ are observed if and only if the individual chooses to drink (the participation equation is set out below). This system of equations is not identified unless there exists exogenous variables that predict intensity but not frequency and correspondingly variables that predict frequency and not intensity. This can be highlighted by looking at the reduced form equations, which are obtained by rearranging the equations (3) and (4):

$$(5) \quad \ln I = \frac{1}{(1-\gamma_I\gamma_F)} [X'(\beta_I + \gamma_I\beta_F) + \gamma_I v_F + v_I]$$

$$(6) \quad \ln F = \frac{1}{(1-\gamma_F\gamma_I)} [X'(\beta_F + \gamma_F\beta_I) + \gamma_F v_I + v_F]$$

This shows in order to identify β_F & β_I exogenous variation is needed in order to identify γ_F & γ_I . With no instruments to identify β_F and γ_F a feasible regression of the above equations 5 and 6 would yield the following estimates:

$$(7) \quad \ln I = X'\theta_I + \varepsilon_I$$

$$(8) \quad \ln F = X'\theta_F + \varepsilon_F$$

where:

$$\theta_I = \frac{(\beta_I + \gamma_I\beta_F)}{(1-\gamma_I\gamma_F)}, \text{ and}$$

$$\varepsilon_I = \frac{\gamma_I v_F + v_I}{(1-\gamma_I\gamma_F)}$$

Similarly for the parameters θ_F and ε_F of the frequency equation. From the feasible regression it is not possible to identify the structural parameters in equations 3 and 4.

The structural model requires instrumental variables (IV) to identify the indirect effects from the direct effects, but this is difficult in practice when so little is known about what influences the intensity and frequency decisions of alcohol drinkers . It is also not clear that structural estimates are desirable in this context. The structural estimates would yield the effect of the parameters on intensity (frequency) holding frequency (intensity) constant or the direct effect. In addition the structural estimates would give the indirect effect, the effect of intensity (frequency) on frequency (intensity). However, the total effect is what we would observe through a policy change and this is what is provided by the reduced form equations. Reduced form equations are therefore estimated in order to avoid hard to justify IV assumptions and because they appear more policy relevant.

The decision to drink and the decision to binge drink

A correction for sample selection is included in the demand equations. This is because a large number of individuals with zero alcohol consumption or zero episodes of binge drinking are observed and this is the result of an explicit decision not to drink or binge drink. OLS is inconsistent in this case. A type II Tobit is used to control for selection endogeneity that relies only on the functional form assumed for the error term of the selection equation. This is because we are unable to justify an exclusion restriction *a priori* as it is not clear which factors are associated with participation and not the quantity decision, and even less so the frequency or intensity decisions. This Heckman two-step method (Heckman, 1979) assumes that the error term from the selection equation ε_1 is standard normal and therefore participation, d , is estimated

via a probit. This then yields the conditional mean for q , given participation (similarly for frequency and intensity):

$$(9) \quad E[q|X, d^* > 0] = X'\beta_2 + \delta E[\varepsilon_1 | \varepsilon_1 > -X'\beta_1] \\ = X'\beta_2 + \delta \lambda(X'\beta_1)$$

where d^* , is an unobserved latent variable representing a drink participation preference parameter that is greater than zero when individuals are observed drinkers ($d=1$) (Cameron and Trivedi, 2005), δ is the covariance of the selection equation error term ε_1 and the quantity equation error term ε_2 . $\lambda(\cdot)$ is the inverse Mills Ratio (IMR) or the hazard ratio where $\lambda = \phi(\cdot) / \Phi(\cdot)$ and represents the probability of being censored assuming ε_1 is distributed standard normal. Estimation via the Heckman two-step procedure allows weaker assumptions than full ML (but is less efficient if the required assumptions for ML are valid). The key assumption is:

$$(10) \quad \varepsilon_2 = \delta \varepsilon_1 + \xi,$$

where $E(\xi|\varepsilon_1) = 0$. Thus unobserved heterogeneity in the quantity (frequency and intensity) equation is accounted for through the correlation between the error terms. If δ is zero then the model becomes just a double hurdle model. Information is provided on the range of probit predictions to assess how well the functional form assumption is predicting the extreme probabilities in order to give an indication of how likely the IMR is to be identified in the quantity, frequency and intensity equations.

Selection equations for drinkers and binge drinkers respectively:

In order to compare drinkers generally (which as a group include binge drinkers) to binge drinkers in particular two participation equations are estimated. The participation equation for all drinkers, where $D = 1$ for a drinker who has alcohol consumption greater than zero in the last 30 days, is given by:

$$(11) \quad D_{ik} = \alpha_k + \sum_j \alpha_{jk} \ln p_j + \beta_k \ln y_i + \sum_l \delta_k \ln Z_l + u_{ik},$$

where, α_k is baseline consumption, p_j is price of alcohol type k , y is monthly income, Z_i is a matrix of covariates other than prices and income that explain the participation decision.

For binge drinkers, a participation equation is also estimated because we are artificially censoring the data for those who are not binge drinkers. The formulation is the same as equation (16) but now $D = 1$ for those who in the last 30 days had at least 1 binge drinking episode (see the data description for the exact definition), 0 if not a binge drinker (not a binge drinker includes non drinkers and drinkers who do not binge drink). It is assumed that the binge drinking decision is its own distinct decision and not a subsequent decision following the decision to drink. Selection into binge drinking is modelled this way because we argue that to binge drink is arguably less to do with the taste of alcohol and more to do with the effects of alcohol. To binge drink is about the decision to get drunk and therefore a different form of selection to that of to drink.

Exogenous variation

In general prices are assumed to be endogenous in a demand system equation. This is because whilst prices affect demand they are also affected by supply. In Sweden alcohol is highly regulated and the only off-licence is the national off-licence monopoly (Systembolaget). In 2012, 63% of alcohol sales were through Systembolaget (Ramstedt et al., 2012) and Sweden has excise duties on alcohol amongst the highest in the world. The normal demand and supply relationship is therefore highly distorted by government taxation and regulation. It is therefore argued that the price index used can be seen as exogenously determined.

Potentially more troublesome are the variables income, employment status and to a lesser extent education. The empirical issues are summarised in Cook (2000). A common result in the literature is that those who drink earn *more* than those who do not. This has been thought to be a problem of misclassification of non-drinkers, as many non-drinkers are previous heavy drinkers, although Jarl and Gerdtham (2010) still find the same relation after controlling for this. Alcohol, it appears, positively affects income at low levels of consumption and negatively for high levels of consumption (Cook, 2000). For most individuals in the sample their education level will have been previously established. Simultaneity will only be an issue for those who have completed their education if current drinking is a good predictor of previous drinking *and* previous drinking behaviour affected educational attainment. For these variables it is only possible to describe the observed association.

3. Results

The results are estimated for males and females separately. The regression results are presented for males and where differences are observed between the genders these are discussed (results for females are found in the appendix). In general between the years 2004 and 2011 reduced drinking participation, reduced participation in binge drinking, reduced frequency of drinking and reduced intensity of drinking episodes is observed (results not shown). Wine is the exception, where the frequency of wine consumption has increased and the average intensity has not fallen over time. More men drink than women. On average men and women have similar wine drinking patterns, but men drink more beer and spirits and are more likely to binge drink. Across all of the regression results the impact of prices is difficult to ascertain. Some variation between the association of the alcohol price indexes and the alcohol demand equations is observed but in general the price responses for each price index are similar across the alcohol types for each alcohol demand regression which suggests the existence of a common trend across the alcohol types that is not necessarily related to the price index changes but is being associated with them as they are the main time varying components in the analysis.

3.1 Selection (participation) decision for alcohol consumption

[insert table II about here]

The results of the alcohol participation decision (**Table II**) are presented as average partial effects from the probit participation model. Younger age groups, the more educated, the more affluent, the employed and students, individuals not living alone and smokers are more likely to drink beer and spirits. Wine drinkers differ from beer and spirits drinkers in that they exhibit a stronger positive education and income gradient and a weaker positive smoking relation. Women and men show statistically

different values for the explanatory variables in the wine participation equation, but are fairly similar in a broader economic sense. For beer and spirits participation women exhibit very different values compared to men, both statistically and economically where the explanatory variables generally exhibit weaker correlation for women. Binge drinking is less correlated with income and education across all types of alcohol, whereas being younger and a smoker are even stronger predictors for binge drinking. All covariates are more similar across the alcohol types for binge drinkers, suggesting binge drinkers distinguish to a lesser extent between the alcohol types.

3.2 Quantity demand for alcohol, given participation

[insert table III about here]

The type II Tobit results for the quantity decision given the individual drinks/is a binge drinker are presented in **Table III**. The fitted value of the Inverse Mills Ratio (IMR) has a statistically significant effect on the wine quantity equation and on the binge drinking spirits quantity equation, for both men and women and for male wine binge drinkers, but not the others. As seen in **Table II** there is mixed success in the Probit model's ability to predict extreme low and high probabilities, especially for women. Therefore, where the IMR is not significant (in **table III**), this does not necessarily suggest that unobserved heterogeneity is not an issue. It is possible that there remains unobserved heterogeneity that is correlated with the errors due to sample selection for the equations where the IMR is non-significant.

The coefficients for the quantity equations follow the same pattern as that observed for the participation equations. The difference is that men who cohabit and or have a university education drink less beer and spirits, even though they are more likely to participate in the consumption of alcohol (no effect for women). There are now differences in the values of the explanatory variables across the alcohol types for the quantity decision of binge drinkers whereas for participation they were broadly similar: those who earn more drink more spirits, but more affluent men drink less wine, more affluent women drink more wine. A university degree is associated with lower beer and spirits consumption (higher wine consumption for women). Smoking is associated with higher consumption for binge drinkers.

3.3 The frequency and intensity demand for alcohol, given participation

[insert tables IVa-c about here]

The reduced form equations for frequency and intensity are shown in **Tables IVa-c**. The interpretation of the explanatory variables in **Tables IVa-c** is that they are both the direct effect of the parameters and the indirect effect through frequency (intensity) on intensity (frequency). For example smoking is positively associated with frequency of beer consumption. This positive association is the combined effect of the direct effect of smoking on frequency *and* the indirect effect of how smoking affects intensity, which in turn affects frequency.

Broadly there is a positive income and education gradient to frequency demand and a negative income and education gradient to intensity demand. Smoking is generally positively associated with both frequency and intensity for all drinkers. Most often,

where a positive gradient for income and education is observed for the quantity equation, this is driven by the positive income and education gradients in frequency demand dominating the negative income and education gradients in intensity demand and vice versa. Women differ slightly from this pattern in that there is no clear relationship between income, education and frequency or intensity for all drinkers of beer and spirits and a positive income and education gradient to intensity demand for wine (all drinkers). For male binge drinkers a positive socioeconomic gradient (income and education) is observed for beer and spirits frequency but not for wine where as for females there is very little difference in the covariates across the alcohol types suggesting alcohol type is not a big factor in differentiating women's alcohol demand but it is for men. For binge drinkers, smoking is generally only associated with demand for frequency.

4. Discussion

This paper has broadened the evidence base regarding frequency and intensity demand for alcohol using a large individual level dataset from Sweden that has allowed the analysis to be extended to different alcohol types, drinker types and to be split by gender. The time period under analysis is interesting as it is a period where a reduction in drinkers, binge drinkers, quantity, frequency and intensity of alcohol consumption has been observed (wine being the exception). The main time varying variable, price, failed to adequately explain the changes in alcohol consumption over time. Counter intuitively; real (inflation adjusted) prices of beer, wine and spirits, in general, fell at the same time that the proportion of the population who drank and the average quantity consumed fell. With the entry to the EU Sweden saw increasing liberalisation of alcohol trade with other EU members and alcohol rules were fully

liberalised by 2004. Alcohol consumption had been increasing up until 2004, but since 2004 overall alcohol consumption has been on the decline (Ramstedt et al., 2012). Preferences for alcohol appear to have changed in Sweden in a way that cannot adequately be explained by changes in price, controlling for other observables. Wine consumption has been on the increase, whilst real prices have fallen, but spirit consumption has been on the decrease whilst real prices have fallen. In addition the alcohol demand equations estimated for beer, wines and spirits generally had the similar associations with the three price indexes for each alcohol type. It appears that alcohol demand has been under some structural shifts common across the alcohol types and not captured by the explanatory variables available.

Previous analysis of the determinants of frequency and intensity of alcohol consumption (Berggren and Sutton, 1999) concluded that income and education are negatively associated with intensity and that neither had an effect on frequency. The results of the current paper on a comparable basis (spirits, all drinkers, but for the whole of Sweden and including prices as regressors and split by gender) find a significant negative education gradient for intensity for males only. However, more generally across different alcohol types and different types of drinkers we find a positive income and education gradient with frequency and a negative income and education gradient with intensity. Thus the results of our paper suggest that the findings of Berggren and Sutton (1999) are specific to spirits and males and not generalisable more widely. Broadly, we find income and education have a positive gradient with drinking and binge drinking participation, quantity and frequency demanded, but a negative gradient with intensity demanded. This suggests that the

positive income gradient with alcohol demand documented in Cook (2000) is a frequency relation and reflects the social value of alcohol.

The key difference between men and women is that women predominantly drink wine. Relatively few women drink beer or spirits (in grams of alcohol terms) whereas men are more evenly split amongst the alcohol types. As a result wine as an alcohol type shows very different patterns of consumption compared to beers and spirits. Women show positive income and education gradients with both frequency and intensity demand for wine. Men only show a positive gradient with income and education for frequency demand for wine. Wine appears to be luxury good, favoured by more affluent and more educated women.

Smoking is also a very large public health concern in many countries. The results of this paper have found that smoking is positively associated with the participation decision to drink/binge drink, the quantity decision (except for binge drinkers of wine) and the frequency and intensity decisions of average drinkers. However, wine as an alcohol type is again different, showing no relationship between smoking and the frequency and intensity demand decision of binge drinkers of wine.

Participation of binge drinkers appears to be less differentiated between the alcohol types in comparison to average drinkers, possibly reflecting a different attitude to alcohol. Across all alcohol types the more affluent and more educated bingers drink less intensely reflecting the increased opportunity cost of intense drinking episodes and possibly health awareness. However, frequency demand also varies by income and education impacting on overall quantity consumed by income and education

group. Female binge drinkers of wine are more similar to binge drinkers of other alcohol types suggesting that binge drinkers see wine as just another alcoholic drink.

As set out in the introduction binge drinkers are associated with higher social costs. The results presented here highlight the complexities associated with attempting to limit the social costs of this harmful drinking behaviour. An alcohol related policy targeted at the low educated would, for example, have to understand why the less educated are less likely to binge drink but the average intensity of low educated individuals who binge drink is higher and they drink less often compared to more highly educated binge drinking individuals. Policy aimed at reducing socioeconomic related health inequalities needs to consider the particular complexities of alcohol demand highlighted in this study. Previous research on socioeconomic related alcohol participation inequality in Sweden by Combes et al., (2011) has found alcohol participation to be pro-rich. This is consistent with the findings of the current paper. However, the demand for intensity by binge drinkers is negatively associated with education and income. Given that binge drinkers who drink most intensely are the individuals who will have the worse wider health outcomes, the findings of this paper suggest it is in fact a pro-poor and negative education gradient that should be the focus of policy, contrary to Combes et al., (2011), if overall socioeconomic health inequality is to be reduced.

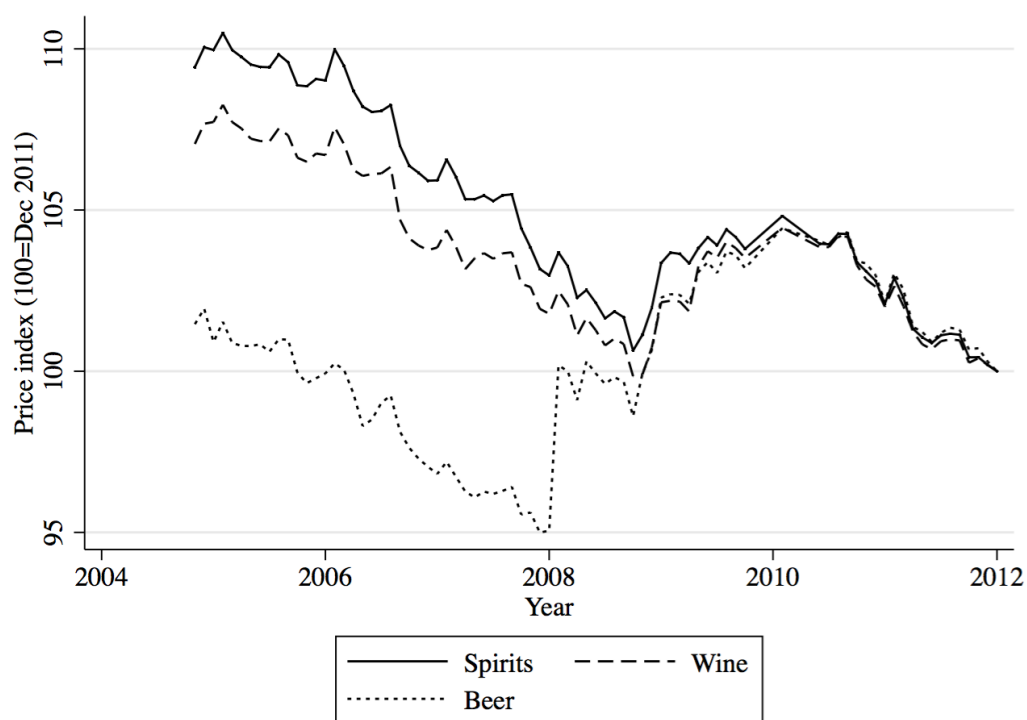
The results presented in this paper are robust associations and are useful for highlighting which groups of individuals policy could most effectively be aimed at in order to improve general health or reduce socioeconomic related health inequality. However, they are not entirely free of endogeneity nor simultaneity. It therefore

cannot be said that policy aimed at changing the factors observed in this study will change the alcohol decision as might be expected if reading the results as a causal model. Future research should overcome this. Initially this could be to explore the effect of smoking on the frequency and intensity of binge drinkers, to establish if this is a causal effect. Smoking's effect on alcohol consumption is especially interesting because the effects on health of smoking *and* drinking are a particular concern for public health.

References

- Berggren, F. & Sutton, M. 1999. Are frequency and intensity of participation decision-bearing aspects of consumption? An analysis of drinking behaviour. *Applied Economics*, 31, 865-874.
- Cameron, A. C. & Trivedi, P. K. 2005. *Microeconometrics : methods and applications*, Cambridge ; New York, Cambridge University Press.
- Chaloupka, F. J. & Wechsler, H. 1996. Binge drinking in college: The impact of price, availability, and alcohol control policies. *Contemporary Economic Policy*, 14, 112-124.
- Combes, J.B., Gerdtham, U.-G. & Jarl, J. 2011. Equalisation of alcohol participation among socioeconomic groups over time: an analysis based on the total differential approach and longitudinal data from Sweden. *International Journal for Equity in Health* 10.
- Cook, Philip J. & Moore, Michael J., 2000. Alcohol. Handbook of Health Economics, in: A. J. Culyer & J. P. Newhouse (ed.), Handbook of Health Economics, edition 1, volume 1, chapter 30, pages 1629-1673 Elsevier.
- Deaton, A. & Muellbauer, J. 1980. *Economics and consumer behavior*, Cambridge ; New York, Cambridge University Press.
- Heckman, J. J. 1979. SAMPLE SELECTION BIAS AS A SPECIFICATION ERROR. *Econometrica*, 47, 153-161.
- Jarl, J. & Gerdtham, U.-G. 2010. Wage penalty of abstinence and wage premium of drinking-A misclassification bias due to pooling of drinking groups? *Addiction Research & Theory*, 18, 284-297.
- Jarl, j., Johansson, P., Eriksson, A., Eriksson, M., Gerdtham, U. G., Hemstrom, O., Selin, K. H., Lenke, L., Ramstedt, M. & Room, R. 2008. The societal cost of alcohol consumption: an estimation of the economic and human cost including health effects in Sweden, 2002. *European Journal of Health Economics*, 9, 351-360.
- Manning, W. G., Blumberg, L. & Moulton, L. H. 1995. The Demand For Alcohol - the differential response to price. *Journal of Health Economics*, 14, 123-148.
- Meiklejohn, J., Connor, J. & Kypri, K. 2012. The Effect of Low Survey Response Rates on Estimates of Alcohol Consumption in a General Population Survey. *Plos One*, 7.
- Naimi, T. S., brewer, R. D., mokdad, A., denny, C., serdula, M. K. & marks, J. S. 2003. Binge drinking among US adults. *Jama-Journal of the American Medical Association*, 289, 70-75.
- Petrie, D., Doran, C., Shakeshaft, A., Sanson-Fisher, R. 2009 The demand for intensity versus frequency of alcohol consumption: Evidence from rural Australia. Dundee Discussion papers in Economics, WP-222.
- Ramstedt, M., Lindell, A., Raninen, J. 2012 Tal om alkohol 2010. Monitor-projektet, SORAD, Stockholm.

Figure 1 – Real alcohol price index changes Sept 2004 – Dec 2011



Notes: Data source: SCB, consumer price index (CPI) for beer, wine and spirits (as per COICOP definition), deflated by headline CPI index to December 2011 prices.

Table 1 – Summary statistics

| Variable | Definition | Whole sample | | Beer drinkers | | Wine drinkers | | Spiriti drinkers | |
|-------------------|--|--------------|--------|---------------|--------|---------------|--------|------------------|--------|
| | | Male | Female | Male | Female | Male | Female | Male | Female |
| | | | | | | | | | |
| DRINKER | 1 = Drank alcohol in last 30 days | 0.82 | 0.73 | - | - | - | - | - | - |
| DRINK_BEER | 1 = Drank beer in last 30 days | 0.60 | 0.25 | - | - | - | - | - | - |
| DRINK_WINE | 1 = Drank wine in last 30 days | 0.54 | 0.63 | - | - | - | - | - | - |
| DRINK_SPIRIT | 1 = Drank spirits in last 30 days | 0.52 | 0.26 | - | - | - | - | - | - |
| BINGE_DRINKER | 1 = Binged in last 30 days | 0.36 | 0.16 | - | - | - | - | - | - |
| LN(FREQUENCY) | ln(No. of days drank in last 30) | | | 1.27 | 0.83 | 1.29 | 1.28 | 0.93 | 0.59 |
| LN(AVG_QUANT) | ln(Average grams pure alcohol/occasion) | | | 1.40 | 0.91 | 1.29 | 1.22 | 1.21 | 0.82 |
| INCOME1 | 1 = Monthly income less than 10,000sek | 0.11 | 0.19 | 0.08 | 0.14 | 0.05 | 0.13 | 0.08 | 0.17 |
| INCOME2 | 1 = Monthly income 10,000-14,999sek | 0.10 | 0.18 | 0.06 | 0.12 | 0.06 | 0.15 | 0.07 | 0.14 |
| INCOME3 | 1 = Monthly income 15,000-19,999sek | 0.14 | 0.20 | 0.12 | 0.20 | 0.11 | 0.20 | 0.13 | 0.19 |
| INCOME4 | 1 = Monthly income 20,000-29,000sek | 0.37 | 0.32 | 0.41 | 0.38 | 0.38 | 0.37 | 0.39 | 0.35 |
| INCOME5 | 1 = Monthly income 30,000-39,999sek | 0.16 | 0.08 | 0.19 | 0.10 | 0.21 | 0.10 | 0.19 | 0.10 |
| INCOME6 | 1 = Monthly income 40,000sek+ | 0.12 | 0.04 | 0.14 | 0.06 | 0.18 | 0.05 | 0.14 | 0.05 |
| COMPULSORY_SCHOOL | 1 = Left school after compulsory education (aged 16 yrs) | 0.28 | 0.26 | 0.22 | 0.17 | 0.19 | 0.19 | 0.24 | 0.21 |
| COLLEGE | 1 = Finished college education (aged 19 years) | 0.40 | 0.35 | 0.45 | 0.40 | 0.38 | 0.35 | 0.42 | 0.35 |
| UNIVERSITY | 1 = Finished University education | 0.32 | 0.39 | 0.33 | 0.43 | 0.42 | 0.46 | 0.35 | 0.43 |
| LNAGE | ln(Age) | 3.79 | 3.83 | 3.74 | 3.74 | 3.84 | 3.84 | 3.79 | 3.78 |
| COHABIT | 1 = Cohabits with one or more adults | 0.74 | 0.69 | 0.76 | 0.73 | 0.78 | 0.71 | 0.76 | 0.72 |
| EMP | 1 = Currently employed | 0.68 | 0.63 | 0.77 | 0.75 | 0.74 | 0.69 | 0.73 | 0.67 |
| UNEMP | 1 = Currently unemployed | 0.03 | 0.03 | 0.02 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 |
| STUDENT | 1 = Currently studying full-time | 0.08 | 0.08 | 0.07 | 0.10 | 0.04 | 0.07 | 0.06 | 0.10 |
| INACTIVE | 1 = Currently inactive(not seeking work, retired) | 0.22 | 0.26 | 0.13 | 0.13 | 0.20 | 0.22 | 0.19 | 0.20 |
| SMOKE | 1 = Smoked in the last 30 days | 0.17 | 0.18 | 0.17 | 0.24 | 0.14 | 0.18 | 0.18 | 0.23 |
| N | | 4841 | 5518 | 2911 | 1404 | 2602 | 3450 | 253 | 1448 |
| | | 6 | 5 | 0 | 4 | 8 | 8 | 85 | 0 |

Notes: 10,000sek in 2014 was roughly equivalent to \$1600 or €1150.

Table 2 –drinking selection equations, males

| VARIABLES | Alcohol selection equation | | | Binge drinking selection equation | | |
|-------------------------------|----------------------------|-------------------|--------------------|-----------------------------------|--------------------|--------------------|
| | Beer | Wine | Spirits | Beer | Wine | Spirits |
| Ln(beer price index) | -0.10 (0.07) | 0.08 (0.07) | -0.43*** (0.07) | -0.27*** (0.06) | -0.16*** (0.06) | -0.32*** (0.06) |
| Ln(wine price index) | -0.78** (0.38) | -0.87** (0.37) | -1.05*** (0.39) | -0.29 (0.34) | -0.01 (0.32) | -0.58* (0.33) |
| Ln(spirit price index) | 1.05*** (0.30) | 1.22*** (0.30) | 1.79*** (0.31) | 0.84*** (0.27) | 0.56** (0.25) | 1.21*** (0.26) |
| INCOME1 (reference) | | | | | | |
| INCOME2 | 0.09*** (0.01) | 0.06*** (0.01) | 0.06*** (0.01) | 0.05*** (0.01) | 0.03*** (0.00) | 0.04*** (0.01) |
| INCOME3 | 0.16*** (0.01) | 0.13*** (0.01) | 0.13*** (0.01) | 0.08*** (0.01) | 0.06*** (0.00) | 0.07*** (0.00) |
| INCOME4 | 0.23*** (0.01) | 0.21*** (0.01) | 0.19*** (0.01) | 0.15*** (0.01) | 0.12*** (0.01) | 0.12*** (0.01) |
| INCOME5 | 0.27*** (0.01) | 0.28*** (0.00) | 0.24*** (0.01) | 0.16*** (0.01) | 0.15*** (0.00) | 0.15*** (0.01) |
| INCOME6 | 0.27*** (0.01) | 0.33*** (0.00) | 0.25*** (0.01) | 0.15*** (0.01) | 0.15*** (0.01) | 0.15*** (0.01) |
| COMPULSORY SCHOOL (Reference) | | | | | | |
| COLLEGE | 0.06*** (0.00) | 0.12*** (0.00) | 0.05*** (0.00) | 0.06*** (0.00) | 0.08*** (0.00) | 0.05*** (0.00) |
| UNIVERSITY | 0.02*** (0.00) | 0.22*** (0.00) | 0.05*** (0.00) | 0.01*** (0.00) | 0.09*** (0.00) | 0.02*** (0.00) |
| LNAGE | -0.19*** (0.00) | 0.18*** (0.00) | -0.02*** (0.00) | -0.30*** (0.00) | -0.10*** (0.00) | -0.23*** (0.00) |
| EMP (reference) | | | | | | |
| INACTIVE | -0.09*** (0.00) | 0.01** (0.00) | 0.02*** (0.00) | -0.12*** (0.00) | -0.09*** (0.00) | -0.07*** (0.00) |
| UNEMP | -0.02** (0.01) | 0.01 (0.01) | 0.00 (0.01) | -0.01 (0.01) | -0.01 (0.01) | -0.02** (0.01) |
| STUDENT | -0.02*** (0.01) | 0.13*** (0.01) | 0.05*** (0.01) | -0.03*** (0.01) | 0.03*** (0.01) | -0.01* (0.01) |
| COHABIT | 0.03*** (0.00) | 0.09*** (0.00) | 0.03*** (0.00) | -0.03*** (0.00) | 0.00 (0.00) | -0.02*** (0.00) |
| SMOKE | 0.08*** (0.00) | 0.02*** (0.00) | 0.11*** (0.00) | 0.13*** (0.00) | 0.08*** (0.00) | 0.12*** (0.00) |
| Predicted min | 0.09 | 0.05 | 0.17 | 0.01 | 0.01 | 0.01 |
| Predicted max | 0.93 | 0.95 | 0.87 | 0.89 | 0.69 | 0.82 |
| N | 48,408 | 48,408 | 48,408 | 48,408 | 48,408 | 48,408 |

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Estimates are average partial effects. Dummies from same category are estimated with all other dummies in same category set to zero. Regional dummies and month dummies are included (Stockholm and January are the reference categories).

Table 3 – Alcohol log-log demand equation estimates, controlling for selection, males

| VARIABLES | Pure alcohol consumed by all drinkers | | | Pure alcohol consumed by binge drinkers | | |
|-------------------------------|---------------------------------------|--------------------|--------------------|---|--------------------|--------------------|
| | Beer | Wine | Spirits | Beer | Wine | Spirits |
| ln(beer price index) | -0.53 (0.41) | 0.35 (0.44) | -0.71 (0.59) | -0.73 (0.56) | 0.57 (0.86) | -2.73* (1.41) |
| ln(wine price index) | -2.24 (2.21) | -8.41*** (2.31) | -4.55* (2.46) | -0.17 (2.72) | -8.53** (4.12) | -9.82 (6.56) |
| ln(spirit price index) | 2.09 (1.80) | 7.93*** (1.86) | 5.96** (2.48) | 0.21 (2.24) | 4.22 (3.50) | 15.37*** (5.75) |
| INCOME1 (Reference) | | | | | | |
| INCOME2 | 0.08 (0.06) | 0.02 (0.06) | -0.06 (0.08) | 0.06 (0.07) | -0.27** (0.13) | 0.31* (0.17) |
| INCOME3 | 0.20** (0.10) | 0.27*** (0.08) | 0.06 (0.15) | 0.14 (0.10) | -0.54** (0.21) | 0.62*** (0.23) |
| INCOME4 | 0.38*** (0.15) | 0.49*** (0.10) | 0.18 (0.21) | 0.29** (0.14) | -0.78** (0.36) | 1.05*** (0.34) |
| INCOME5 | 0.43** (0.17) | 0.78*** (0.14) | 0.24 (0.27) | 0.29* (0.17) | -0.87* (0.47) | 1.39*** (0.43) |
| INCOME6 | 0.35** (0.17) | 1.00*** (0.15) | 0.28 (0.29) | 0.18 (0.16) | -0.71 (0.48) | 1.43*** (0.43) |
| COMPULSORY SCHOOL (Reference) | | | | | | |
| COLLEGE | 0.09** (0.04) | 0.37*** (0.05) | -0.10** (0.05) | 0.08 (0.05) | -0.19 (0.19) | 0.14 (0.12) |
| UNIVERSITY | -0.13*** (0.02) | 0.62*** (0.09) | -0.27*** (0.05) | -0.14*** (0.03) | -0.05 (0.21) | -0.25*** (0.08) |
| LNAGE | -0.90*** (0.10) | 0.89*** (0.07) | -0.13*** (0.04) | -0.81*** (0.23) | 1.37*** (0.24) | -1.63*** (0.50) |
| EMP (reference) | | | | | | |
| INACTIVE | -0.29*** (0.06) | 0.01 (0.02) | 0.21*** (0.03) | -0.25* (0.13) | 0.61** (0.24) | -0.18 (0.21) |
| UNEMP | 0.06 (0.05) | 0.14** (0.06) | 0.16*** (0.05) | 0.06 (0.06) | 0.12 (0.09) | 0.00 (0.14) |
| STUDENT | -0.10** (0.04) | 0.31*** (0.07) | 0.07 (0.08) | -0.10* (0.05) | -0.14 (0.11) | -0.12 (0.13) |
| COHABIT | -0.19*** (0.02) | 0.20*** (0.04) | -0.13*** (0.04) | -0.21*** (0.03) | 0.04 (0.03) | -0.29*** (0.06) |
| SMOKE | 0.44*** (0.04) | 0.17*** (0.02) | 0.43*** (0.11) | 0.41*** (0.10) | -0.29 (0.19) | 1.22*** (0.27) |
| IMR | 0.41 (0.33) | 0.83*** (0.22) | 0.28 (0.62) | 0.40 (0.35) | -1.76** (0.85) | 3.09*** (0.90) |
| Constant | 8.71*** (2.06) | -1.79 (2.51) | -0.87 (2.92) | 8.78*** (2.60) | 17.69*** (6.15) | -9.08 (6.62) |
| Participation observations | 48,435 | 48,435 | 48,435 | 48,435 | 48,435 | 48,435 |
| Quantity observations | 29,110 | 26,028 | 25,385 | 15,632 | 11,699 | 13,450 |
| Proportion drink/binge | 60% | 54% | 52% | 32% | 24% | 28% |

Notes: *** p<0.01, ** p<0.05, * p<0.1. Month dummies to capture resampling effects and seasonality and regional dummies are included in all models (Stockholm and January are the reference categories).

Table 4a – Reduced form equation estimates of beer frequency and intensity demand, males

| | All drinkers | | Binge drinkers | |
|-------------------------------|-------------------|--------------------|--------------------|--------------------|
| | Frequency | Intensity | Frequency | Intensity |
| Ln(beer price index) | -0.47 (0.33) | -0.06 (0.24) | -1.00* (0.51) | 0.28 (0.37) |
| Ln(wine price index) | -3.44* (1.77) | 1.20 (1.26) | -2.43 (2.56) | 2.26 (1.82) |
| Ln(spirit price index) | 3.50** (1.44) | -1.41 (1.03) | 3.26 (2.09) | -3.05** (1.49) |
| INCOME1 (Reference) | | | | |
| INCOME2 | 0.08 (0.05) | 0.01 (0.04) | 0.13* (0.06) | -0.06 (0.05) |
| INCOME3 | 0.23*** (0.08) | -0.03 (0.06) | 0.27*** (0.08) | -0.12** (0.06) |
| INCOME4 | 0.38*** (0.11) | -0.01 (0.08) | 0.48*** (0.12) | -0.19** (0.09) |
| INCOME5 | 0.49*** (0.13) | -0.07 (0.10) | 0.61*** (0.14) | -0.32*** (0.11) |
| INCOME6 | 0.49*** (0.13) | -0.13 (0.10) | 0.59*** (0.14) | -0.41*** (0.10) |
| COMPULSORY SCHOOL (Reference) | | | | |
| COLLEGE | 0.08*** (0.03) | 0.00 (0.02) | 0.18*** (0.05) | -0.09*** (0.03) |
| UNIVERSITY | -0.01 (0.02) | -0.12*** (0.01) | 0.04 (0.03) | -0.18*** (0.02) |
| LNAGE | -0.10 (0.07) | -0.80*** (0.06) | -0.48** (0.20) | -0.33** (0.15) |
| EMP (reference) | | | | |
| INACTIVE | -0.12** (0.05) | -0.17*** (0.04) | -0.27** (0.11) | 0.01 (0.08) |
| UNEMP | 0.00 (0.04) | 0.06** (0.03) | -0.04 (0.05) | 0.11*** (0.04) |
| STUDENT | -0.01 (0.04) | -0.09*** (0.03) | -0.05 (0.05) | -0.05 (0.04) |
| COHABIT | -0.01 (0.02) | -0.18*** (0.01) | -0.08*** (0.03) | -0.13*** (0.02) |
| SMOKE | 0.26*** (0.03) | 0.18*** (0.02) | 0.42*** (0.08) | -0.02 (0.06) |
| IMR | 0.56** (0.25) | -0.15 (0.19) | 0.98*** (0.29) | -0.58*** (0.22) |
| Constant | 2.78* (1.65) | 5.93*** (1.18) | 2.54 (2.43) | 6.24*** (1.73) |
| Participation observations | 48,435 | 48,435 | 48,435 | 48,435 |
| Freq/intens observations | 29110 | 29113 | 15632 | 15635 |
| Proportion drink/binge | 60% | 60% | 32% | 32% |

Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parenthesis. Month dummies to capture resampling effects and seasonality and regional dummies are included in all models (Stockholm and January are the reference categories).

Table 4b – Reduced form equation estimates of wine frequency and intensity demand, males

| | All drinkers | | Binge drinkers | |
|-------------------------------|-------------------|--------------------|-------------------|--------------------|
| | Frequency | Intensity | Frequency | Intensity |
| Ln(beer price index) | -0.03 (0.39) | 0.39* (0.20) | -0.00 (0.63) | 0.58 (0.41) |
| Ln(wine price index) | -4.59** (2.05) | -3.89*** (1.07) | -3.89 (2.94) | -4.62** (1.94) |
| Ln(spirit price index) | 4.69*** (1.65) | 3.31*** (0.87) | 1.41 (2.55) | 2.83* (1.67) |
| INCOME1 (Reference) | | | | |
| INCOME2 | 0.03 (0.05) | -0.01 (0.03) | -0.15 (0.10) | -0.12* (0.07) |
| INCOME3 | 0.28*** (0.06) | -0.01 (0.04) | -0.32* (0.17) | -0.22** (0.11) |
| INCOME4 | 0.51*** (0.09) | -0.01 (0.05) | -0.41 (0.29) | -0.37** (0.18) |
| INCOME5 | 0.80*** (0.11) | -0.02 (0.07) | -0.41 (0.38) | -0.46* (0.24) |
| INCOME6 | 1.03*** (0.13) | -0.03 (0.07) | -0.25 (0.39) | -0.46* (0.25) |
| COMPULSORY SCHOOL (Reference) | | | | |
| COLLEGE | 0.37*** (0.04) | -0.01 (0.03) | -0.07 (0.15) | -0.12 (0.10) |
| UNIVERSITY | 0.66*** (0.07) | -0.04 (0.04) | 0.07 (0.17) | -0.13 (0.11) |
| LNAGE | 0.97*** (0.06) | -0.08** (0.03) | 1.03*** (0.19) | 0.34*** (0.12) |
| EMP (reference) | | | | |
| INACTIVE | 0.14*** (0.02) | -0.13*** (0.01) | 0.46** (0.19) | 0.15 (0.12) |
| UNEMP | 0.07 (0.05) | 0.07*** (0.03) | 0.02 (0.07) | 0.10** (0.05) |
| STUDENT | 0.38*** (0.06) | -0.07** (0.04) | -0.03 (0.08) | -0.11** (0.05) |
| COHABIT | 0.28*** (0.03) | -0.08*** (0.02) | 0.13*** (0.02) | -0.09*** (0.01) |
| SMOKE | 0.10*** (0.02) | 0.07*** (0.01) | -0.18 (0.15) | -0.12 (0.10) |
| IMR | 1.02*** (0.11) | -0.18* (0.09) | -1.02 (0.69) | -0.74* (0.43) |
| Constant | -4.46** (2.19) | 2.69** (1.18) | 10.40** (4.75) | 7.08** (3.04) |
| Participation observations | 48,408 | 48,408 | 48,408 | 48,408 |
| Freq/intens observations | 26028 | 26031 | 11699 | 11702 |
| Proportion drink/binge | 54% | 54% | 24% | 24% |

Notes: *** p<0.01, ** p<0.05, * p<0.1. Month dummies to capture resampling effects and seasonality and regional dummies are included in all models (Stockholm and January are the reference categories).

Table 4c – Reduced form equation estimates of spirit frequency and intensity demand, males

| | All drinkers | | Binge drinkers | |
|-------------------------------|-------------------|--------------------|--------------------|--------------------|
| | Frequency | Intensity | Frequency | Intensity |
| Ln(beer price index) | -0.70 (0.43) | -0.02 (0.37) | -2.07** (0.94) | -0.64 (0.54) |
| Ln(wine price index) | -3.64** (1.80) | -1.08 (1.52) | -6.21 (4.37) | -3.72 (2.49) |
| Ln(spirit price index) | 4.65** (1.81) | 1.43 (1.53) | 9.90*** (3.83) | 5.46** (2.22) |
| INCOME1 (Reference) | | | | |
| INCOME2 | -0.02 (0.06) | -0.04 (0.05) | 0.20* (0.11) | 0.11* (0.07) |
| INCOME3 | 0.09 (0.11) | -0.03 (0.09) | 0.45*** (0.15) | 0.16* (0.09) |
| INCOME4 | 0.20 (0.15) | -0.02 (0.13) | 0.76*** (0.23) | 0.27** (0.14) |
| INCOME5 | 0.30 (0.20) | -0.05 (0.17) | 1.04*** (0.29) | 0.33* (0.18) |
| INCOME6 | 0.37* (0.21) | -0.10 (0.18) | 1.14*** (0.29) | 0.27 (0.18) |
| COMPULSORY SCHOOL (Reference) | | | | |
| COLLEGE | 0.01 (0.04) | -0.12*** (0.03) | 0.19** (0.08) | -0.06 (0.05) |
| UNIVERSITY | 0.03 (0.04) | -0.30*** (0.03) | 0.08 (0.05) | -0.33*** (0.03) |
| LNAGE | 0.25*** (0.03) | -0.38*** (0.02) | -0.82** (0.33) | -0.79*** (0.21) |
| EMP (reference) | | | | |
| INACTIVE | 0.20*** (0.02) | 0.00 (0.02) | -0.12 (0.14) | -0.05 (0.09) |
| UNEMP | 0.08** (0.04) | 0.08** (0.03) | -0.03 (0.10) | 0.04 (0.05) |
| STUDENT | 0.15*** (0.06) | -0.07 (0.05) | 0.03 (0.08) | -0.15*** (0.05) |
| COHABIT | -0.01 (0.03) | -0.12*** (0.02) | -0.11*** (0.04) | -0.17*** (0.02) |
| SMOKE | 0.22*** (0.08) | 0.20*** (0.07) | 0.74*** (0.18) | 0.47*** (0.11) |
| IMR | 0.33 (0.44) | -0.05 (0.38) | 2.06*** (0.60) | 0.99*** (0.37) |
| Constant | -2.01 (2.12) | 1.29 (1.80) | -6.64 (4.40) | -2.06 (2.54) |
| Participation observations | 48,408 | 48,408 | 48,408 | 48,408 |
| Freq/intens observations | 25385 | 25388 | 13450 | 13453 |
| Proportion drink/binge | 52% | 52% | 28% | 28% |

Notes: *** p<0.01, ** p<0.05, * p<0.1. Month dummies to capture resampling effects and seasonality and regional dummies are included in all models (Stockholm and January are the reference categories).

Appendix

Table A2f - Drinking selection equation for females

| VARIABLES | Alcohol selection equation | | | Binge drinking selection equation | | |
|-------------------------------|----------------------------|--------------------|--------------------|-----------------------------------|--------------------|--------------------|
| | Beer | Wine | Spirits | Beer | Wine | Spirits |
| Ln(beer price index) | -0.10 (0.06) | 0.09 (0.06) | -0.04 (0.06) | -0.12*** (0.04) | -0.04 (0.05) | -0.11*** (0.04) |
| Ln(wine price index) | -1.12*** (0.33) | -1.15*** (0.34) | -2.47*** (0.33) | -0.08 (0.22) | 0.28 (0.25) | 0.04 (0.21) |
| Ln(spirit price index) | 1.43*** (0.26) | 1.26*** (0.27) | 2.89*** (0.26) | 0.43** (0.17) | 0.13 (0.20) | 0.39** (0.16) |
| INCOME1 (reference) | | | | | | |
| INCOME2 | 0.02*** (0.00) | 0.07*** (0.00) | 0.02*** (0.00) | 0.01*** (0.00) | 0.02*** (0.00) | 0.01*** (0.00) |
| INCOME3 | 0.06*** (0.00) | 0.13*** (0.00) | 0.04*** (0.00) | 0.02*** (0.00) | 0.03*** (0.00) | 0.02*** (0.00) |
| INCOME4 | 0.09*** (0.00) | 0.19*** (0.00) | 0.08*** (0.00) | 0.04*** (0.00) | 0.06*** (0.00) | 0.04*** (0.00) |
| INCOME5 | 0.10*** (0.00) | 0.26*** (0.00) | 0.12*** (0.00) | 0.05*** (0.00) | 0.07*** (0.00) | 0.06*** (0.00) |
| INCOME6 | 0.12*** (0.01) | 0.28*** (0.01) | 0.12*** (0.01) | 0.06*** (0.00) | 0.08*** (0.00) | 0.06*** (0.00) |
| COMPULSORY SCHOOL (Reference) | | | | | | |
| COLLEGE | 0.05*** (0.00) | 0.10*** (0.00) | 0.02*** (0.00) | 0.04*** (0.00) | 0.07*** (0.00) | 0.03*** (0.00) |
| UNIVERSITY | 0.04*** (0.00) | 0.15*** (0.00) | 0.04*** (0.00) | 0.03*** (0.00) | 0.06*** (0.00) | 0.03*** (0.00) |
| LNAGE | -0.05*** (0.00) | 0.17*** (0.00) | -0.03*** (0.00) | -0.12*** (0.00) | -0.16*** (0.00) | -0.14*** (0.00) |
| EMP (reference) | | | | | | |
| INACTIVE | -0.10*** (0.00) | -0.06*** (0.00) | -0.00 (0.00) | -0.05*** (0.00) | -0.05*** (0.00) | -0.02*** (0.00) |
| UNEMP | 0.00 (0.01) | -0.03*** (0.01) | 0.01** (0.01) | 0.01 (0.00) | -0.01* (0.01) | 0.01 (0.00) |
| STUDENT | 0.04*** (0.01) | 0.13*** (0.01) | 0.10*** (0.01) | 0.03*** (0.00) | 0.03*** (0.00) | 0.03*** (0.00) |
| COHABIT | 0.02*** (0.00) | 0.05*** (0.00) | 0.03*** (0.00) | -0.02*** (0.00) | -0.03*** (0.00) | -0.02*** (0.00) |
| SMOKE | 0.10*** (0.00) | 0.03*** (0.00) | 0.09*** (0.00) | 0.09*** (0.00) | 0.09*** (0.00) | 0.07*** (0.00) |
| Predicted min | 0.03 | 0.15 | 0.06 | 0.00 | 0.00 | 0.00 |
| Predicted max | 0.59 | 0.94 | 0.66 | 0.58 | 0.62 | 0.60 |
| N | 55,182 | 55,182 | 55,182 | 55,182 | 55,182 | 55,182 |

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Estimates are average partial effects. Dummies from same category are estimated with all other dummies in same category set to zero. Regional dummies and month dummies are included (Stockholm and January are the reference categories)

Table A3f – Alcohol log-log demand equation estimates, controlling for selection, females

| VARIABLES | Pure alcohol consumed by all drinkers | | | Pure alcohol consumed by binge drinkers | | |
|-------------------------------|---------------------------------------|--------------------|--------------------|---|-------------------|--------------------|
| | Beer | Wine | Spirits | Beer | Wine | Spirits |
| ln(beer price index) | -0.59 (1.56) | 0.20 (0.37) | -0.80 (0.71) | 0.65 (1.21) | 0.09 (0.76) | -1.27 (1.59) |
| ln(wine price index) | -12.63 (9.70) | -6.29*** (1.98) | -14.18* (7.96) | -9.22* (5.28) | -4.66 (3.94) | -9.11 (7.38) |
| ln(spirit price index) | 15.59 (9.64) | 6.00*** (1.62) | 16.23* (8.82) | 9.14* (4.83) | 5.10* (3.05) | 13.94** (6.35) |
| INCOME1 (Reference) | | | | | | |
| INCOME2 | 0.34* (0.18) | 0.14*** (0.04) | 0.05 (0.07) | 0.22 (0.14) | 0.17 (0.11) | 0.22 (0.16) |
| INCOME3 | 0.75* (0.39) | 0.33*** (0.07) | 0.30* (0.16) | 0.22 (0.18) | 0.20 (0.13) | 0.35* (0.21) |
| INCOME4 | 1.05** (0.53) | 0.51*** (0.10) | 0.47* (0.26) | 0.34 (0.28) | 0.39* (0.22) | 0.65* (0.34) |
| INCOME5 | 1.27* (0.65) | 0.73*** (0.12) | 0.68* (0.39) | 0.32 (0.39) | 0.63** (0.29) | 0.98** (0.49) |
| INCOME6 | 1.43* (0.76) | 0.79*** (0.13) | 0.72* (0.40) | 0.34 (0.42) | 0.74** (0.33) | 1.01** (0.52) |
| COMPULSORY SCHOOL (Reference) | | | | | | |
| COLLEGE | 0.56** (0.28) | 0.29*** (0.05) | 0.06 (0.06) | 0.26 (0.25) | 0.42* (0.22) | 0.25 (0.23) |
| UNIVERSITY | 0.40 (0.25) | 0.43*** (0.07) | 0.06 (0.13) | 0.15 (0.19) | 0.54*** (0.20) | 0.13 (0.23) |
| LNAGE | -1.26*** (0.29) | 0.50*** (0.08) | -0.47*** (0.09) | -1.30* (0.72) | 0.04 (0.50) | -2.27** (0.95) |
| EMP (reference) | | | | | | |
| INACTIVE | -1.07* (0.57) | -0.13*** (0.03) | 0.15*** (0.04) | -0.18 (0.34) | -0.18 (0.18) | -0.14 (0.18) |
| UNEMP | 0.21 (0.16) | 0.03 (0.05) | 0.25*** (0.09) | 0.29*** (0.11) | -0.04 (0.08) | 0.21 (0.15) |
| STUDENT | 0.46* (0.25) | 0.36*** (0.07) | 0.60* (0.31) | 0.10 (0.16) | 0.23** (0.11) | 0.40* (0.23) |
| COHABIT | 0.11 (0.14) | 0.14*** (0.03) | 0.06 (0.09) | -0.22* (0.12) | -0.12 (0.08) | -0.33*** (0.11) |
| SMOKE | 1.32** (0.53) | 0.23*** (0.02) | 0.70*** (0.26) | 0.70 (0.48) | 0.38 (0.29) | 1.21*** (0.46) |
| IMR | 3.94* (2.20) | 0.67** (0.29) | 1.91 (1.26) | 0.90 (1.08) | 0.86 (0.82) | 2.54** (1.21) |
| Constant | -10.94 (10.46) | -0.08 (2.07) | -5.48 (7.49) | 2.21 (7.79) | -1.53 (6.31) | -11.44 (11.16) |
| Participation observations | 55,186 | 55,186 | 55,186 | 55,186 | 55,186 | 55,186 |
| Quantity observations | 14,044 | 34,319 | 13,886 | 4,946 | 7,331 | 4,812 |
| Proportion drink/binge | 25% | 62% | 25% | 9% | 13% | 9% |

Notes: *** p<0.01, ** p<0.05, * p<0.1. Month dummies to capture resampling effects and seasonality and regional dummies are included in all models (Stockholm and January are the reference categories).

Table A4a_f – Reduced form equation estimates of beer frequency and intensity demand, females

| | All drinkers | | Binge drinkers | |
|-------------------------------|-------------------|--------------------|-------------------|--------------------|
| | Frequency | Intensity | Frequency | Intensity |
| Ln(beer price index) | -0.65 (1.62) | 0.05 (0.33) | -0.80 (1.66) | 1.45 (1.10) |
| Ln(wine price index) | -13.69 (10.03) | 1.06 (2.30) | -8.94 (7.73) | -0.27 (5.13) |
| Ln(spirit price index) | 16.69* (9.96) | -1.10 (2.49) | 12.69* (6.71) | -3.55 (4.46) |
| INCOME1 (Reference) | | | | |
| INCOME2 | 0.28 (0.19) | 0.06 (0.05) | 0.33* (0.17) | -0.11 (0.11) |
| INCOME3 | 0.68* (0.41) | 0.07 (0.11) | 0.40* (0.22) | -0.18 (0.14) |
| INCOME4 | 1.01* (0.55) | 0.05 (0.15) | 0.75** (0.33) | -0.41* (0.22) |
| INCOME5 | 1.27* (0.68) | 0.00 (0.19) | 0.97** (0.45) | -0.65** (0.30) |
| INCOME6 | 1.45* (0.79) | -0.02 (0.22) | 1.09** (0.50) | -0.75** (0.33) |
| COMPULSORY SCHOOL (Reference) | | | | |
| COLLEGE | 0.54* (0.29) | 0.02 (0.08) | 0.68** (0.29) | -0.42** (0.20) |
| UNIVERSITY | 0.47* (0.26) | -0.07 (0.07) | 0.56** (0.23) | -0.41*** (0.15) |
| LNAGE | -0.51* (0.30) | -0.75*** (0.08) | -1.80** (0.83) | 0.50 (0.55) |
| EMP (reference) | | | | |
| INACTIVE | -1.03* (0.59) | -0.03 (0.16) | -0.72* (0.39) | 0.54** (0.26) |
| UNEMP | 0.04 (0.16) | 0.17*** (0.03) | 0.14 (0.15) | 0.15 (0.10) |
| STUDENT | 0.44* (0.26) | 0.02 (0.07) | 0.37* (0.20) | -0.27** (0.13) |
| COHABIT | 0.28* (0.14) | -0.17*** (0.04) | -0.25* (0.14) | 0.04 (0.09) |
| SMOKE | 1.12** (0.55) | 0.20 (0.15) | 1.29** (0.55) | -0.59 (0.36) |
| IMR | 4.07* (2.27) | -0.13 (0.64) | 2.67** (1.22) | -1.78** (0.81) |
| Constant | -14.74 (10.81) | 3.80 (2.63) | -11.96 (9.95) | 14.17** (6.61) |
| Participation observations | 55,186 | 55,186 | 55,186 | 55,186 |
| Freq/intens observations | 14,044 | 14,044 | 4,946 | 4,946 |
| Proportion drink/binge | 25% | 25% | 9% | 9% |

Notes: *** p<0.01, ** p<0.05, * p<0.1. Month dummies to capture resampling effects and seasonality and regional dummies are included in all models (Stockholm and January are the reference categories).

Table A4b_f – Reduced form equation estimates of wine frequency and intensity demand, females

| | All drinkers | | Binge drinkers | |
|-------------------------------|-------------------|--------------------|-------------------|-----------------|
| | Frequency | Intensity | Frequency | Intensity |
| Ln(beer price index) | 0.22 (0.30) | -0.02 (0.17) | -0.17 (0.75) | 0.27 (0.42) |
| Ln(wine price index) | -3.56** (1.60) | -2.74*** (0.94) | -1.56 (3.91) | -3.13 (2.19) |
| Ln(spirit price index) | 3.15** (1.30) | 2.86*** (0.77) | 2.87 (3.04) | 2.15 (1.70) |
| INCOME1 (Reference) | | | | |
| INCOME2 | 0.07* (0.03) | 0.07*** (0.02) | 0.16 (0.10) | 0.00 (0.06) |
| INCOME3 | 0.20*** (0.05) | 0.14*** (0.03) | 0.20* (0.12) | -0.01 (0.07) |
| INCOME4 | 0.34*** (0.08) | 0.18*** (0.05) | 0.45** (0.19) | -0.08 (0.12) |
| INCOME5 | 0.53*** (0.10) | 0.19*** (0.06) | 0.76*** (0.26) | -0.16 (0.16) |
| INCOME6 | 0.59*** (0.10) | 0.20*** (0.06) | 0.89*** (0.29) | -0.18 (0.18) |
| COMPULSORY SCHOOL (Reference) | | | | |
| COLLEGE | 0.22*** (0.04) | 0.08*** (0.03) | 0.47** (0.19) | -0.07 (0.12) |
| UNIVERSITY | 0.40*** (0.06) | 0.03 (0.04) | 0.62*** (0.17) | -0.10 (0.11) |
| LNAGE | 0.62*** (0.07) | -0.11*** (0.04) | -0.23 (0.44) | 0.31 (0.27) |
| EMP (reference) | | | | |
| INACTIVE | 0.02 (0.03) | -0.15*** (0.02) | -0.21 (0.16) | 0.04 (0.10) |
| UNEMP | 0.01 (0.04) | 0.02 (0.02) | -0.09 (0.08) | 0.06 (0.05) |
| STUDENT | 0.29*** (0.06) | 0.07** (0.03) | 0.28*** (0.10) | -0.06 (0.06) |
| COHABIT | 0.16*** (0.02) | -0.02 (0.01) | -0.09 (0.07) | -0.02 (0.05) |
| SMOKE | 0.10*** (0.02) | 0.14*** (0.01) | 0.48* (0.26) | -0.12 (0.16) |
| IMR | 0.48** (0.23) | 0.19 (0.14) | 1.35* (0.71) | -0.55 (0.44) |
| Constant | -0.98 (1.67) | 0.88 (0.99) | -5.65 (5.73) | 4.59 (3.44) |
| Participation observations | 55,182 | 55,182 | 55,182 | 55,182 |
| Freq/intens observations | 34,508 | 34,508 | 7,347 | 7,347 |
| Proportion drink/binge | 63% | 63% | 13% | 13% |

Notes: *** p<0.01, ** p<0.05, * p<0.1. Month dummies to capture resampling effects and seasonality and regional dummies are included in all models (Stockholm and January are the reference categories).

Table A4c_f – Reduced form equation estimates of spirits frequency and intensity demand, females

| | All drinkers | | Binge drinkers | |
|-------------------------------|-------------------|--------------------|-------------------|-------------------|
| | Frequency | Intensity | Frequency | Intensity |
| Ln(beer price index) | -0.36 (0.42) | -0.43 (0.40) | -0.59 (1.31) | -0.62 (0.73) |
| Ln(wine price index) | -7.22 (5.32) | -6.44 (4.75) | -5.55 (6.05) | -3.46 (3.14) |
| Ln(spirit price index) | 8.23 (5.98) | 7.40 (5.30) | 9.83* (5.20) | 3.73 (2.86) |
| INCOME1 (Reference) | | | | |
| INCOME2 | 0.01 (0.05) | 0.04 (0.04) | 0.17 (0.13) | 0.03 (0.08) |
| INCOME3 | 0.14 (0.11) | 0.15 (0.09) | 0.27 (0.17) | 0.06 (0.11) |
| INCOME4 | 0.23 (0.18) | 0.22 (0.16) | 0.52* (0.28) | 0.09 (0.19) |
| INCOME5 | 0.35 (0.27) | 0.31 (0.24) | 0.79** (0.40) | 0.13 (0.27) |
| INCOME6 | 0.42 (0.27) | 0.27 (0.24) | 0.94** (0.42) | 0.02 (0.28) |
| COMPULSORY SCHOOL (Reference) | | | | |
| COLLEGE | 0.05 (0.04) | 0.01 (0.04) | 0.34* (0.19) | -0.11 (0.13) |
| UNIVERSITY | 0.09 (0.09) | -0.04 (0.08) | 0.34* (0.19) | -0.22* (0.12) |
| LNAGE | 0.08 (0.06) | -0.54*** (0.06) | -1.51* (0.78) | -0.67 (0.54) |
| EMP (reference) | | | | |
| INACTIVE | 0.13*** (0.03) | 0.02 (0.02) | -0.14 (0.15) | 0.01 (0.10) |
| UNEMP | 0.10* (0.06) | 0.15*** (0.05) | 0.10 (0.12) | 0.11* (0.07) |
| STUDENT | 0.33 (0.22) | 0.25 (0.19) | 0.37* (0.19) | 0.01 (0.12) |
| COHABIT | 0.05 (0.06) | 0.00 (0.05) | -0.19** (0.09) | -0.13** (0.06) |
| SMOKE | 0.29 (0.18) | 0.40** (0.16) | 0.88** (0.38) | 0.29 (0.26) |
| IMR | 0.85 (0.87) | 0.97 (0.76) | 2.08** (0.99) | 0.34 (0.69) |
| Constant | -4.01 (5.02) | -0.99 (4.48) | -15.12* (9.17) | 4.60 (5.78) |
| Participation observations | 55,182 | 55,182 | 55,182 | 55,182 |
| Freq/intens observations | 14,480 | 14,480 | 4,904 | 4,904 |
| Proportion drink/binge | 26% | 26% | 9% | 9% |

Notes: *** p<0.01, ** p<0.05, * p<0.1. Month dummies to capture resampling effects and seasonality and regional dummies are included in all models (Stockholm and January are the reference categories).