SEX UNDER THE INFLUENCE ? REVISITING THE EFFECTS OF ALCOHOL TAXES ON SEXUALLY TRANSMTTED DISEASE RATES

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Abstract[1]

This paper examines the effect of beer and alcohol taxes on sexually transmitted disease (STD) rates. Contrary to Chesson *et al*. (2000), our findings show that alcohol taxes have statistically insignificant effects on STD rates. Hence, we caution against placing undue hope in alcohol taxes as an effective tool to combat risky sexual behavior and the spread of STDs.

Keywords: Sexually Transmitted Disease, Dynamic Panel Models, Beer and Liquor Tax
JEL Classification: K, I1, and C5

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1. Introduction

Alcohol abuse and the resulting problems continue to pose a serious social challenge in the U.S., and researchers continue to explore the policies that may effectively combat those problems. In this regard, economists have been very interested in investigating causal factors that determine the demand for alcohol. Many papers present evidence that alcohol consumption is sensitive to the price of alcohol, which suggests that higher alcohol taxes may be a viable tool for controlling alcohol demand and the problems arising from excessive alcohol consumption.

In a recent article, Chesson, Harrison and Kassler (2000) extend this direction of research by investigating the effects of alcohol policy on the state-level rates of sexually transmitted diseases over the period 1981-95. They argue that alcohol policy provides a viable tool for regulating sexual behavior, thus reducing the cost burden of sexually transmitted disease (hereafter STDs) on society. The primary alcohol policy these authors focus on is state excise taxes on beer and liquor, and the two STDs of interest are gonorrhea and syphilis. They find very substantive negative effects of taxes on these diseases. For example, they estimate that a $1 increase in the per-gallon beer tax will reduce gonorrhea rates and syphilis rates by 25.4 percent and 93.3 percent respectively, and the same increase in per-gallon liquor tax will reduce the rates by 2.1 percent and 9.9 percent respectively. Thus, they conclude that there is strong evidence that alcohol policy can affect STD rates.

The magnitudes and high statistical significance of the tax effects in the above study are somewhat surprising, given certain recent findings in the literature regarding the effects of alcohol policy, particularly beer taxes. One cause for concern is that, unlike most other studies that explore the effect of alcohol taxes on various state level phenomena (these will be elaborated upon in the next section), Chesson *et al.* do not control for other state level variables which can potentially impact the dependent variable and may not be entirely absorbed by state fixed effects. In addition, there is an issue regarding the estimation technique. The estimation of the model for STD rates is complicated by its dynamic structure due to the expected persistence effect in the incidence rate of a communicable disease. In case of such dynamic panel models, using the standard within estimator frequently leads to biased and inconsistent coefficient estimates.

Given that findings pertaining to the effect (non-effect) of higher alcohol taxes on STD rates are particularly important from a policy perspective, we are motivated to further explore the issue of effect of alcohol taxes on STDs. The primary goal of our study is to extend the work of Chesson *et al*. by employing relevant econometric methods, while controlling for important omitted variables that may not be entirely captured by the fixed effects. Our findings show that, by and large, alcohol taxes have insignificant effects on STD rates. Hence, we caution against placing undue hope in alcohol taxes as an effective tool to combat risky sexual behavior and the spread of STDs.

2. Background

Previous Results

High rates of alcohol consumption may have a number of associated negative externalities -- which include health issues, participation in physical violence, traffic fatalities and engagement in risky sexual activity. Therefore, given the possible benefits of moderating alcohol consumption, economists have been interested in investigating what factors govern the demand for alcohol, and hence have the potential for serving as a tool to regulate that demand. Specifically, the role of higher taxes on alcohol consumption has been extensively researched, and a widely cited body of empirical studies has presented findings that support the sensitivity of alcohol demand to higher taxes (Coate & Grossman, 1988; Kenkel, 1993; Cook and Moore, 1994). Evidence has also been presented regarding the negative effect of higher alcohol taxes on rate of traffic fatalities, (Saffer & Grossman, 1987; Chaloupka *et al*., 1993) and on violence on college campuses (Grossman & Markowitz, 1999). However, an emerging recent body of literature is beginning to challenge many of these findings, specifically contending that many of these results might be affected by omitted variable bias. Most of the above studies rely on cross-sectional variation in state alcohol taxes, and an alternate hypothesis is that there may be unobserved state-specific attributes that influence both the level of alcohol taxation and the prevalence of alcohol consumption. Hence, effects of alcohol tax on alcohol consumption are exaggerated due to their correlation with these omitted unobserved attributes. Evidence in support of this hypothesis is growing. Dinardo and Lemieux (1992) employ Monitoring the Future (MTF) data from 1980-89, and variety of model specifications. They find that alcohol consumption is not affected by alcohol prices per se after inclusion of state level dummies to control for unobserved state heterogeneity. Mast *et al*. (1999) find a non-effect of beer tax on alcohol consumption after the inclusion of state fixed effects and proxies for local 'drinking sentiments' in the model. Dee (1999) uses MTF data for 1972-92, and verifies that beer taxes appear to have a significant and negative effect on alcohol consumption if state fixed effects are excluded, but cease to be statistically significant (and often have the incorrect sign) once the effects are incorporated. This result holds for all drinkers, as well as separately for "moderate" and "heavy" drinkers, and is robust to inclusion of additional variables. Furthermore, Dee (1999) finds that beer taxes appear to decrease traffic fatalities in panel data models that incorporate only state and year fixed effects, but cease to have any significant effect once state-specific time trends are also incorporated. Markowitz and Grossman (2000) find that beer taxes appear to have a negative and significant impact upon the likelihood of physical child abuse when state fixed-effects are excluded, but the effects cease to be statistically significant with the inclusion of state fixed effects. Finally, Young and Likens (2000) find that neither the beer tax nor the over-all beer price have any significant effect either on over-all traffic fatalities or on alcohol-involved fatalities in specific once state and year fixed effects and a variety of other state-level characteristics are included in the model.

Given this growing evidence that, after controlling for state and year specific unobservables, beer taxes may not significantly impact alcohol consumption per se and may not impact phenomena like alcohol-related traffic fatalities and physical child abuse, it is perhaps surprising that Chesson *et al.* find such substantive and significant effects of alcohol taxes on STD rates. We speculate that this may in part be driven omitted variable biases, since the authors do not control for other variables that might influence STD rates and may not be entirely captured by the fixed effects. Moreover, as mentioned before, there is an issue regarding the estimation technique given the dynamic nature of the model specification. We explore these issues in the next sub-section.

Issues in Econometric Estimation

In order to examine whether sexually transmitted disease (STD) rates respond to changes in alcohol taxes, we consider estimating the following dynamic panel model where the lagged dependent variable appears as a regressor.

$$\log(R_{it}) = a_i + g_t + d \log(R_{i,t-1}) + b\, Tax_{it} + u_{it}\,, \quad i = 1,..N;\ t=1,..T. \qquad (1)$$

where R_{it} is the STD rate; a_i and g_t capture state-specific and time-specific fixed effects; Tax_{it} is either the per-gallon beer tax or the per-gallon liquor tax in 1998 dollars; and u_{it} is the error term. The estimation of this model is complicated by its dynamic structure. Such dynamic models have been popular in estimating a partial adjustment or habit-persistence model (see Houthakker & Taylor, 1970, and Baltagi *et al.*, 2000, among many others). The persistence effect is expected in this case as the incidence rate of a communicable disease depends in part on the prior prevalence rate of that disease.

Omitting the year and state dummy variables and applying the ordinary least squares method to estimate equation (1) leads to invalid estimators. The resulting OLS estimates will be biased and inconsistent, because not only will $R_{i,t-1}$ be correlated with v_{it}, where $v_{it} = a_i + g_t + u_{it}$, but the primary variable of interest, Tax_{it}, will also be correlated with v_{it}. Accordingly, inclusion of the year and state specific dummies is particularly important.[2] Including those dummies and applying the ordinary least squares method amounts to doing the within transformation which accounts for state and year specific fixed effects.[3] While the within estimator controls for unobserved heterogeneity, it still poses a serious problem. It is now well known in the literature that, in case of dynamic models, the within estimator or fixed effects estimator is also biased and inconsistent (see, for example, Nickell, 1981; Kiviet, 1995; Baltagi & Griffin, 1997).[3] This occurs because the transformed lagged dependent variable is still correlated with the error term, and this endogeneity problem induces bias not only in the estimated coefficient of the lagged dependent variable, but in

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[2] Coate and Grossman (1988) summarize the two ways in which effects of alcohol taxes may be correlated to the state (or area) specific 'drinking sentiment.' States where a large section of the population are opposed to drinking may impose high alcohol taxes as a part of the political process. In such a case, OLS methods will *overstate* the impact of alcohol taxes. Conversely, states with strong pro-drinking sentiments and high alcohol consumption may impose high taxes as an easy way to increase revenue. If such is the case, then OLS methods will *understate* the impact of alcohol taxes. Hence, the state effects capture inter-state variation in 'drinking sentiment' that remains invariant over time. Similarly, the year effects capture inter-temporal variation in drinking sentiment for the country as a whole.

[3] As was done in Chesson *et al.* (2000).

[4] There are many papers that examine the bias problem of the within estimator; see also Trognon (1978), Sevestre and Trognon (1985), Beggs & Nerlove, (1988), Ridder and Wansbeek (1990), Ridder & Wansbeek (1990), and Hsiao, Pesaran and Tahmiscioglu (1999).

the estimated coefficients of the other independent variables as well (see Nickell, 1981, for calculations of magnitudes of the respective biases).[5] Regular random effects estimators of dynamic panel models suffer from the same endogeneity problem. Given strong theoretical econometric findings indicating bias of the usual fixed effects and random effects estimators, we may have grounds to suspect the results from using the usual fixed effect models ignoring the endogeneity problem of the lagged dependent variable. The next section reveals that this suspicion is not entirely unfounded.

In addition to the endogeneity bias problem of regular panel data estimators in dynamic panel models, we are also concerned with omitted variable biases. Chesson *et al.* control for state and time fixed effects, but ignore the fact that STD rates may be affected by *other factors* that are neither time invariant within a state, nor are identical across all states in any year. Omission of such factors may impact the alcohol tax coefficients. Also, it is possible that certain unobservables within states change over time in ways that are different from other states. To

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[5] In examining the effect of alcohol taxes on the STD rates, Chesson *et al.* dismiss the endogeneity bias problem, arguing that the bias problem may be a mere asymptotic result and the degree of bias may be an empirical matter. In that regard, they cited simulation results of Baltagi and Griffin (1997) who showed that correcting for possible endogeneity in the lagged dependent variable does not necessarily warrantee good forecasting performance. Truly, the reliability of the employed estimator depends on various factors including the sample sizes (N and T), the relative variability of the data, model specifications of the state and time fixed effects, deterministic trends and choice of relevant instruments. A recent paper by Judson and Owen (1999) is particularly interesting in this case. They have examined the question, "How big should T be before the bias can be ignored?" and provided simulation evidence that the bias of the within estimator for dynamic panel data models can be sizable even when $T = 20$ or 30. Thus, they conclude that one should not dismiss the bias of the within estimator as insignificant.

capture this, we incorporate state dummies multiplied by the time trend.[6] Hence, the models can be revised as:

$$\log(R_{it}) = a_i + g_t + d \log(R_{i,t-1}) + b\ Tax_{it} + X_{it}'\gamma + u_{it}, \quad i = 1,..N;\ t=1,..T. \qquad (2)$$

as well as

$$\log(R_{it}) = a_i + g_t + t^* a_i + d \log(R_{i,t-1}) + b\ Tax_{it} + X_{it}'\gamma + u_{it}, \quad i = 1,..N;\ t=1,..T. \qquad (3)$$

where $t^* a_i$ are the state-specific time trends, and X_{it} is a vector of other time-variant state characteristics that affect STD rates. Additionally, we also estimate and present results for models of the form

$$\log(R_{it}) = a_i + g_t + d \log(R_{i,t-1}) + b \log(Tax_{it}) + X_{it}'\gamma + u_{it}, \quad i = 1,..N;\ t=1,..T. \qquad (4)$$

and

$$\log(R_{it}) = a_i + g_t + t^* a_i + d \log(R_{i,t-1}) + b \log(Tax_{it}) + X_{it}'\gamma + u_{it}, \quad i = 1,..N;\ t=1,..T. \qquad (5).$$

All results are presented in the following section.

3. Estimation Methods and Results

In this section, we empirically investigate the effect of beer or liquor taxes on STD rates. We employ different econometric techniques that are known to be free of the endogeneity problem in the dynamic structure of the model. In addition, we include time variant independent variables. Like Chesson *et al.*, our data set covers the fifteen-year time period of 1981-1995. We obtain the data for STD rates per 100,000 population by state directly from the Centers for Disease Control

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[6] Chesson *et al.* do report estimates from equations of gonorrhea rates that include state trends. They find that alcohol taxes still exert substantial negative effects on the rates, though the effect of the beer tax is now only significant at the 10 percent level.

and Prevention. We also use the data on per gallon beer and liquor taxes.[7] We transform the nominal taxes using June 1998 price levels.

As discussed above, we also include a vector of other state characteristics, X_{it}, which are time variant and may not be captured entirely either by state and year fixed effects or by state specific trends. Surveillance reports from the Centers for Disease Control and Prevention indicate that STD rates are higher among adolescents, and attribute the phenomenon to the greater likelihood of adolescents having multiple sexual partners, engaging in unprotected intercourse, and exercising less discretion when choosing partners compared to adults. The reports also indicate differences in STD rates between whites and minorities, which may result from minority status being correlated to other fundamental determinants of health status like poverty and lack of access to quality health care. Hence, we include in X_{it} the percentage of state population aged between 15-19 years (teenperc), the percentage of state population who are black (blackperc), and the percentage of state population in poverty (povrate). We also recognize that STD rates may be influenced by other state policies that have the potential to affect choices regarding sexual activity. Two such policies are welfare generosity (which can affect the opportunity cost of child-bearing), and availability of Medicaid funding for abortion (which can impact the price of obtaining an abortion). Therefore, we also include in X_{it} the maximum AFDC funding available to a family of 3 per month (adjusted using CPI 82-84=100) (maxafdc) and the number of years since the state restricted Medicaid funding for terminating non-life threatening, non-rape pregnancies

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[7] We obtained these data from Dr. Harrell Chesson, who very generously shared the alcohol tax information that they received from the Distilled Spirits Council of the United States (DISCUS).

(medrestlngth). The latter figure always takes the value of '0' for states that have not imposed such restrictions.[8]

We focus on results relating to gonorrhea rates for the following reasons: Firstly, syphilis rates are far lower than gonorrhea rates. Therefore, in many cases, small changes in the absolute rate can translate into very large percentage changes, making coefficient estimates extremely volatile. Secondly, syphilis rates are very unevenly distributed, with many states having very low syphilis incidence. Indeed, in recent years more than half of the nation's new syphilis cases have been concentrated in just 31 counties (out of the nation's 3,115).[9] Hence, while we have replicated all results presented here for syphilis rates too, we do not report them, though they are available upon request.

We begin by using the fixed effect estimator that include state and year effects but does not correct for the endogeneity problem that results from the lagged dependent variable. The results are given in columns FE 1 and FE 2 in Table 1. The null hypothesis of the absence of fixed effects is decisively rejected in all cases. Our results are very similar to those obtained by Chesson *et al.*,

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[8] Data on percentage of adolescents, blacks, and on poverty rates were obtained from the Census Bureau. Data on maximum AFDC funding is available from the Urban Institute, and we are grateful to Traci Mach for directing us to that source. Rebecca Blank very generously shared information on Medicaid restriction dates up to 1988 (see Blank, George & London, 1996). We updated it to 1995 using the information in Haas-Wilson (1996) and Sollom (1997).

[9] Also, our communications with Dr. Chesson revealed that they have used data on syphilis rates among the population aged 25 years and older, whereas we only have data on syphilis rates among the over-all population. Insofar as we are interested in exploring whether their original findings remain unchanged with the employment of additional variables and more accurate statistical techniques, presenting results using syphilis rates seem somewhat futile, since the results will differ anyway due to the difference in data.

[10] They are, of course, available upon request.

though not identical.[11] The noteworthy changes between our results and theirs are that while they found the effect of beer taxes to be significant at the 10 percent level even after including state-specific trends, in our case the effect falls short of being significant at that level. On the other hand, our estimates of liquor tax have smaller standard errors and hence greater statistical significance, though the magnitudes of the effects remain comparable to theirs.[13] The long-run multiplier estimate, which is calculated as $1/(1-\hat{d})$ where $\hat{d}$ is the coefficient of the lagged dependent variable, is 6.17 in both equations with beer tax and liquor tax when just state and year fixed effects are controlled for. They become 2.16 and 2.15 respectively when the state-specific time trends are additionally included. These testify to a substantial 'persistence effect' in STD infection rates.

Next, we look at the effect of added regressors, X_{it}. The primary purpose of this experiment is to investigate whether, even without altering the estimation techniques to correct for endogeneity,

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[11] Communication with Dr. Chesson revealed that, because we obtained our data-set more recently than they did, the STD rates per 100,000 population that the Center sent us were probably computed using more updated information on state population sizes, which accounts for some small differences between our data and the data of Chesson *et al.*

[12] Our results differ somewhat from those of Chesson et al. Communication with Dr. Chesson revealed that, because we obtained our data-set more recently than they did, the STD rates per 100,000 population that the Center sent us were probably computed using more updated information on state population sizes, which accounts for some small differences between our data and the data of Chesson *et al.*

[13] The coefficient on the tax variables indicates the responsiveness of STD rates to a dollar increase per gallon in taxes. However, it should be pointed out that the mean sample value of the beer tax in 1998 dollars is $0.287, and that of the liquor tax is $2.813. Hence, a 'dollar increase per gallon' in beer taxes constitutes more than a 300 percent increase based on the mean value, whereas a 'dollar increase per gallon' in liquor taxes constitutes a 35.5 percent increase based on the mean value. Hence, elasticities calculated at the mean value of taxes, or the later equations that use log of taxes rather than absolute values, offers a more informative picture of the responsiveness of STD rates to different alcohol prices.

the effects of alcohol taxes are impacted by inclusion of variables in X_{it}. The results from the equations with X_{it} are given in columns FE 3 and FE 4. The results that include X_{it} present a different picture, and strongly suggest that the omission of relevant variables lead to over-estimation of the effects of alcohol taxes.[15] Specifically, we find that inclusion of any combination of X_{it} and state-specific time trends eliminates the statistical significance of the per gallon beer tax. The per gallon liquor tax remains significant at the 10 percent level in the model excluding the state trends, but not in the model including the state trends. The over-all implication is that the effects of alcohol taxes are not robust to the inclusion of additional state-level controls.

With regard to the variables included in X_{it}, we find evidence that, after controlling for state and year fixed effects and state-specific trends, a higher proportion of adolescents in the state population increase the incidence of STDs, as does greater welfare generosity in the state. We also find that, contrary to popular opinion, a higher percentage of blacks in the state is associated with a *lower* incidence of STDs. This result, however, has similar precedents in the economic literature and is not entirely surprising.[16] What is perhaps surprising is that, after controlling for

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[15] According to the F-test, the joint non-significance of the coefficients of X_{it}, is not rejected at the 5% significance level in cases when only the state and year fixed effects are allowed for. However, the joint restriction is rejected in the model specification where the state-specific trends are additionally included.

[16] Prior studies have found that, after controlling for other socio-economic factors, being black has no effect or negative effects on the likelihood of early initiation into sexual activity or non-contracepted sex

state unobservables, poverty rates in the state have a counter-intuitive sign, though the result is, at best, weakly significant.

Hereafter, we address the issue of endogeneity of the lagged dependent variable and present results from endogeneity-corrected estimation techniques that correct for that. Several solutions suggested in the literature to fix the bias problem of regular panel data estimators in dynamic panel models. We report the results using three different estimators.

First, we employ two-stage least squares using as instruments lagged values of the dependent variable, say $R_{i,t-2}$ or ($R_{i,t-2}$, $R_{i,t-3}$) for $R_{i,t-1}$, while controlling the state fixed effects. These are valid instruments that are not correlated with the error term. Unlike the usual 2SLS estimator that does not control for the state fixed effects, the within 2SLS (hereafter, FE-2SLS) estimator is consistent even if the state fixed effects are correlated with any of the regressors.[17] We report the result using $R_{i,t-2}$ as an instrument for $R_{i,t-1}$.

(Brewster, 1994; Abe, 1999), as well as no effects or negative effects on indulging in addictive substances (Pacula, 1998; Chatterji, 1999; Caetano & Clark (forthcoming); Sen, Agarwal & Hofler, 2001).

[17] We also estimated the equations employing a generalized two-stage least squares random effects estimator, which treats the state specific effects as random. This method uses a consistent estimator of the variance matrix of the disturbance and then applies two-stage least squares using between and within variations in the exogenous variables and the lagged values as instruments. We employ the error components two-stage least squares (RE-EC2SLS) estimator of Baltagi (1981). The assumption in this specification is that the state-specific unobserved components are uncorrelated with alcohol taxes in that state, which we believe is inappropriate in this case. Hence, we do not present results from the RE-EC2SLS model, though they are available on request. However, it is worth mentioning that these results failed to find evidence of either alcohol tax exerting any negative effect on gonorrhea rates, even at the 10 percent level of significance.

Second, we adopt the first difference method proposed by Anderson and Hsiao (1981). They employ the first difference transformation of the model to wipe out the state fixed effects and use $R_{i,t-2}$ or $DR_{i,t-2}$ as an instrument for the transformed variable, $DR_{i,t-1}$.

Lastly, we adopt Arellano and Bond's (1991) method of utilizing additional instruments involved in a dynamic panel data model. Note that the GMM estimators are more efficient than other estimators that use a set of fewer instrument variables. Their methods adopt a GMM estimation based on the identified orthogonality conditions that exist between lagged values of R_{it} and the error term. Using the large instrument matrix derived from these orthogonality conditions, Arellano and Bond suggested two different estimators; the one-step and two-step GMM estimator. The two-step estimator uses the estimated differenced residuals obtained from the first-step GMM estimator that is based on assumed difference matrix of the error term.[18]

In Table 2, we respectively present results from the FE-2SLS, Anderson-Hsiao's first-difference estimator (FD-2SLS), and the Arellano-Bond GMM estimator. In each case, the equations are estimated with and without inclusion of state trends, and with and without inclusion of X_{it}. We find that coefficient estimates for both types of alcohol taxes are highly sensitive to both the method used and the inclusion of X_{it}. The main findings can be summarized as follows:

(1) The result of primary interest is that, after the inclusion of both X_{it} and state specific trends, both types of alcohol taxes fail to impact gonorrhea rates even at the 10 percent level of significance. This result remains consistent for all model specifications, and emphasize that the results of the original authors may have suffered from omitted variable bias.

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[18] Other extended methods by Arellano and Bover (1993), Ahn and Schmidt (1993) and Keane and Runkle (1992) may arguably be more efficient when they use more valid instruments for the GMM estimation, but are beyond the scope of this paper.

(2) Over-all, the tax effects do the most poorly in the Anderson-Hsiao FD model. They fail to have a negative and significant effect irrespective of exclusion of X_{it} and state specific trends.[19] In the FE-2SLS model, both beer and liquor taxes fail to have a significant effect whenever X_{it} is included.

(3) Results of the Arellano-Bond model come the closest to supporting the contention that beer taxes may be effective in reducing gonorrhea rates.[20] The coefficient is negative and statistically significant at the 5 percent level in model specifications that exclude the state trend, and significant at the 10 percent level in the specification that includes state trends but excludes X_{it}. The liquor tax coefficient is negative and significant at the 10 percent or lower levels in specifications that exclude X_{it}. However, as mentioned in (1), the coefficients for both taxes cease to be statistically significant once X_{it} *and* state-specific trends are included in the model specification.

Though we will present results using (log) taxes after this, it may be worth commenting on the elasticities of the tax effects at this point as well. Elasticities are, in many ways, a better indication of the responsiveness of STD rates to alcohol taxes than the effects of $1 changes in the per gallon tax. Using the tax coefficients, we calculate elasticities at the sample mean of per gallon beer

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[19] The coefficient of the lagged dependent variable is shown to be insignificant in the FD-2SLS estimation. Even considering the fact that it represents the persistence effect from the transformed variables, we find this result somewhat unexpected, compared to those from the GMM estimation that utilizes extensive orthogonality conditions.

[20] The Sargan's over-identifying restriction test is rejected from the result using the one-step GMM estimator, which may indicate the existence of heteroskedasticity, but it is not rejected from the result using the two-step GMM estimator. Arellano and Bond (1991) recommend using the one-step estimator for inference on the coefficients, while the two-step Sargan test is superior on model specification. Thus, we report the result using the one-step GMM estimator.

taxes ($0.287) and at the sample mean of per gallon liquor taxes ($2.813), and present those in Tables 1 and 2. Over-all, the elasticities of STD responsiveness to tax increases is fairly low, ranging between –0.02 to –0.23 for beer taxes, and between –0.02 and –0.17 for liquor taxes.

Table 3 presents results from re-estimating the models in Table 1, with the difference that *log* of tax rates are now substituted in place of tax rates. Again, the results indicate that the effects of taxes are not very robust to alternate specifications. Beer taxes are now significant at only the 10 percent level in the first model where state-specific trends and X_{it} are excluded, and fail to be significant even at the 10 percent level in all specifications that include X_{it}. Liquor tax effects, on the other hand, remain significant at the 5 percent level in the specification that includes both X_{it} and state-specific time trends, fail to be significant in the specification that excludes state-specific trends.

Table 4 repeats the estimation procedures in Table 2 with log tax rates substituted in place of actual tax rates. These results show that beer taxes always fail to be significant for the Anderson-Hsiao FD-2SLS method. In case of the FE-2SLS, or the Arellano-Bond GMM method, beer taxes have a significantly negative effect only when X_{it} are excluded. Once X_{it} are included, taxes cease to be significant even at the 10 percent level irrespective of the inclusion of state-specific trends. The magnitudes of the elasticities range from –0.018 to –0.15 in value. Liquor taxes also fail to be significant in all cases when the Anderson-Hsiao FD-2SLS method is used. However, in case of the other two methods, they are significant when X_{it} are excluded, insignificant when X_{it} are included but state-specific trends are excluded, and significant at the 10 percent level when both X_{it} and state-specific trends are included. The magnitudes of the elasticities range from –0.096 to –0.27 in value. All these results combined lead us to reaffirm that the result that alcohol taxes have negative and statistically significant impacts on STD rates are not robust to using different estimation techniques and different model specifications. In particular, the effects of alcohol taxes cease to be statistically significant in most cases we consider.

4. Concluding Remarks

The primary goal of this work has been to re-visit the issue of the effect of alcohol taxes on STD rates, and expand on the original work by Chesson *et al*. (2000) on that topic. Our results lead us to conclude that negative and significant alcohol tax effects on STD rates are, in fact, not supported. Specifically, we find that *once both additional state level variables and state-specific time trends are included in the model specification*, beer taxes fail to be statistically significant regardless of estimation technique, and liquor taxes are at best statistically significant at the 10 percent level for some estimation techniques and insignificant for the others. The statistical significance of alcohol tax effects in other model specifications (that do not include both X_{it} and state-specific time trends) also varies greatly with the estimation technique used. Hence, we are unable to find convincing evidence that alcohol taxes help curb the kind of risky sexual behavior that lead to STD infections.

As described in the literature review section, recent studies in the economic literature are casting doubts on the true effectiveness of alcohol taxes in curbing alcohol consumption and hence in curbing phenomena related to alcohol consumption, like traffic fatalities. This new but growing body of literature has strong policy implications in that it indicates that relying on higher alcohol taxes to curb alcohol related problems may be a flawed and perhaps futile technique. Our work adds to this literature, and cautions against relying on alcohol taxes as an effective tool to curb risky sexual behavior and the spread of STDs.

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Table 1

Models with Lagged STD Rates (Not Correcting for Endogeneity).

Dependant Variable: Gonorrhea rate (log)	Beer Tax				Liquor Tax			
	FE 1	FE 2	FE 3	FE 4	FE 1	FE 2	FE 3	FE 4
Lagged STD	.838 (41.9)	.539 (14.6)	.834 (39.9)	.509 (13.7)	.838 (41.9)	.536 (14.5)	.831 (39.5)	.506 (13.7)
Tax	-.312 (-2.49)	-.337 (-1.51)	-.183 (-1.34)	-.108 (-.48)	-.030 (-2.33)	-.044 (-2.31)	-.023 (-1.74)	-.031 (-1.61)
Teenperc			-.001 (.19)	.082 (2.07)			-.005 (-.30)	.079 (2.02)
Blperc			.003 (.19)	-.109 (-2.14)			.001 (.09)	-.104 (-2.04)
PovRate			-.004 (-1.13)	-.007 (-1.61)			-.004 (-1.19)	-.007 (-1.70)
MaxAFDC (in $100s)			.048 (2.03)	.097 (2.43)			.054 (2.35)	.096 (2.42)
Medrestlngth			.002 (.56)	-.019 (-.71)			.002 (.56)	-.020 (-.74)
State Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Trend	No	Yes	No	Yes	No	Yes	No	Yes
Elasticity (at mean value of tax)*	-0.09	-0.10	-0.05	-0.03	-0.08	-0.12	-0.06	-0.09
Adj. R^2	.979	.981	.979	.981	.979	.981	.979	.981
R^2	.9805	.9838	.9807	.9845	.9805	.9838	.9808	.9845
F-stat. on all $\mu_i = 0$[a]	2.52 (.0)	2.11 (.0)	2.32 (.0)	2.58 (.0)	2.50 (.0)	2.21 (.0)	2.28 (.0)	2.58 (.0)
Overall significance F-stat. (d.f.)	496.8 (65, 641)	311.4 (115, 591)	462.3 (70, 636)	309.8 (120, 586)	496.1 (65, 641)	313.0 (115, 591)	463.2 (70, 636)	311.0 (120, 586)
F-test[a]	1 vs 2	F = 2.41 (.000)			1 vs 2	F = 2.41 (.000)		
	1 vs 3	F = 1.32 (.254)			1 vs 3	F = 1.99 (.079)		
	1 vs 4	F = 2.75 (.000)			1 vs 4	F = 2.75 (.000)		
	2 vs 4	F = 5.29 (.000)			2 vs 4	F = 5.29 (.000)		
	3 vs 4	F = 2.87 (.000)			3 vs 4	F = 2.80 (.000)		

Note: t-statistics in parentheses.

* Sample mean of beer tax is $0.287 per gallon, of liquor tax is $2.813 per gallon (adjusted using CPI June, 1998).

[a] p-values of the F-test are given in parentheses.

Table 2

Models with Lagged STD Rates (Corrected for Endogeneity)

(a) Beer Tax

Dependant Variable: Gonorrhea rate (log)	FE-2SLS				FD-2SLS				GMM			
	FE 1	FE 2	FE 3	FE 4	FD 1	FD 2	FD 3	FD 4	GMM1	GMM2	GMM3	GMM4
Lagged STD	.818 (32.3)	.263 (3.22)	.812 (30.4)	.250 (3.05)	.369 (.41)	1.30 (1.24)	.338 (.36)	1.29 (1.27)	.810 (25.8)	.667 (12.7)	.750 (20.0)	.621 (11.7)
Tax	-.422 (-3.00)	-.391 (-1.47)	-.260 (-1.68)	-.079 (-.30)	-.220 (-.65)	-.067 (-.14)	-.164 (-.45)	-.002 (-.0)	-.797 (-3.36)	-.550 (-1.86)	-.593 (-2.28)	-.157 (-.52)
Additional Regressors	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
State Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Trend	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Elasticity (at mean value of tax)*	-0.12	-0.11	-0.07	-0.02	-0.06	-0.02	-0.05	-0.001	-0.23	-0.16	-0.17	-0.05
F-stat. on all $\mu_i = 0$[a]	2.09 (.0)	1.66 (.004)	1.99 (.0)	1.89 (.0)								
Sargan's test (One-step)[a]									216.4 (.0)	226.6 (.0)	214.9 (.0)	211.1 (.0)
Sargan's test (Two-step) [a]									45.3 (1.0)	11.5 (1.0)	34.9 (1.0)	1.9 (1.0)

(b) Liquor Tax

Dependant Variable: Gonorrhea rate (log)	FE-2SLS				FD-2SLS				GMM			
	FE 1	FE 2	FE 3	FE 4	FD 1	FD 2	FD 3	FD 4	GMM1	GMM2	GMM3	GMM4
Lagged STD	.820 (37.6)	.519 (13.2)	.811 (35.6)	.488 (12.4)	.418 (.48)	1.28 (1.21)	.376 (.41)	1.28 (1.25)	.830 (26.9)	.664 (12.7)	.757 (20.3)	.620 (11.6)
Tax	-.035 (-2.41)	-.045 (-2.09)	-.026 (-1.76)	-.030 (-1.39)	-.025 (-.76)	-.009 (-.21)	-.026 (-.75)	-.008 (-.20)	-.042 (-1.78)	-.053 (-2.09)	-.028 (-1.11)	-.031 (-1.21)
Additional Regressors	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
State Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Trend	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Elasticity (at mean value of tax)*	-0.10	-0.13	-0.07	-0.08	-0.07	-0.03	-0.07	-0.02	-0.12	-0.15	-0.08	-0.09
F-stat. on all $\mu_i = 0$[a]	2.44 (.0)	2.05 (.0)	2.37 (.0)	2.37 (.0)								
Sargan's test (One-step)[a]									221.2 (.0)	226.0 (.0)	217.4 (.0)	209.7 (.0)
Sargan's test (Two-step) [a]									40.8 (1.0)	15.2 (1.0)	35.8 (1.0)	2.25 (1.0)

Note: t-statistics in parentheses.

* Sample mean of beer tax is $0.287 per gallon, of liquor tax is $2.813 per gallon (adjusted using CPI June, 1998).

[a] P-values are given in parentheses.

Table 3

Models with Lagged STD Rates and Log Taxes (Not Correcting for Endogeneity).

Dependant Variable: Gonorrhea rate (log)	**Beer Tax**				**Liquor Tax**			
	FE 1	FE 2	FE 3	FE 4	FE 1	FE 2	FE 3	FE 4
Lagged STD	.843 (42.5)	.531 (14.4)	.836 (40.1)	.504 (13.6)	.744 (24.8)	.527 (12.2)	.738 (22.9)	.474 (11.1)
Tax	-.054 (-1.77)	-.127 (-2.76)	-.021 (-.65)	-.070 (-1.50)	-.153 (-2.65)	-.250 (-2.89)	-.090 (-1.49)	-.174 (-2.01)
Teenperc			-.002 (-.13)	.079 (2.01)			-.017 (-.71)	.110 (2.35)
Blperc			.003 (.13)	-.099 (-1.95)			.009 (.65)	-.027 (-0.50)
PovRate			-.004 (-1.18)	-.007 (-1.62)			-.006 (-1.35)	-.008 (-1.82)
MaxAFDC (in $100s)			.055 (2.38)	.088 (2.19)			.061 (2.41)	.173 (3.72)
Medrestlngth			.002 (.57)	-.019 (-.71)			.003 (.70)	-.001 (-.14)
State Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Trend	No	Yes	No	Yes	No	Yes	No	Yes
Adj. R^2	.978	.981	.979	.981	.972	.975	.972	.977
R^2	.9804	.9838	.9807	.9845	.9750	.9793	.9759	.9808
F-stat. on all $\mu_i = 0$[a]	2.44 (.0)	2.12 (.0)	2.50 (.0)	2.56 (.0)	2.92 (.0)	2.41 (.0)	2.37 (.0)	2.68 (.0)
Overall significance F-stat. (d.f.)	494.3 (65, 641)	314.2 (115, 591)	461.3 (70, 636)	311.1 (120, 586)	496.1 (65, 641)	313.0 (115, 591)	463.2 (70, 636)	311.0 (120, 586)
F-test[a]	1 vs 2	F = 2.55 (.000)			1 vs 2	F = 3.95 (.000)		
	1 vs 3	F = 1.59 (.160)			1 vs 3	F = 2.26 (.047)		
	1 vs 4	F = 2.83 (.000)			1 vs 4	F = 4.48 (.000)		
	2 vs 4	F = 4.83 (.000)			2 vs 4	F = 6.15 (.000)		
	3 vs 4	F = 2.93 (.000)			3 vs 4	F = 3.02 (.000)		

Note: t-statistics in parentheses.

[a] p-values of the F-test are given in parentheses.

Table 4

Models with Lagged STD Rates and Log Taxes (Corrected for Endogeneity)

(a) Beer Tax (log)

Dependant Variable: Gonorrhea rate (log)	FE-2SLS				FD-2SLS				GMM			
	FE 1	FE 2	FE 3	FE 4	FD 1	FD 2	FD 3	FD 4	GMM1	GMM2	GMM3	GMM4
Lagged STD	.827 (38.1)	.517 (13.2)	.816 (36.2)	.488 (12.4)	.023 (.55)	-.083 (-1.85)	.024 (.56)	-.090 (-2.01)	.835 (27.1)	.661 (12.6)	.760 (20.4)	.618 (11.6)
Tax (log)	-.072 (-2.17)	-.121 (-2.41)	-.032 (-.86)	-.062 (-1.21)	-.037 (-.67)	-.041 (-.71)	-.023 (-.41)	-.018 (-.30)	-.121 (-2.23)	-.152 (-2.41)	-.090 (-1.53)	-.058 (-.89)
Additional Regressors	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
State Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Trend	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
F-stat. on all $\mu_i = 0$[a]	2.42 (.0)	2.06 (.0)	2.37 (.0)	2.42 (.0)								
Sargan's test (One-step)[a]									218.9 (.0)	225.2 (.0)	216.7 (.0)	212.0 (.0)
Sargan's test (Two-step)[a]									42.7 (1.0)	11.6 (1.0)	41.5 (1.0)	1.38 (1.0)

(b) Liquor Tax (log)

Dependant Variable: Gonorrhea rate (log)	FE-2SLS				FD-2SLS				GMM			
	FE 1	FE 2	FE 3	FE 4	FD 1	FD 2	FD 3	FD 4	GMM1	GMM2	GMM3	GMM4
Lagged STD	.726 (21.3)	.506 (11.2)	.715 (20.5)	.451 (10.1)	-.037 (-.71)	-.088 (-1.62)	-.037 (-.72)	-.095 (-1.75)	.745 (16.2)	.614 (11.2)	.702 (14.3)	.564 (9.99)
Tax (log)	-.176 (-2.71)	-.243 (-2.53)	-.096 (-1.35)	-.168 (-1.77)	-.154 (-1.54)	-.150 (-1.40)	-.145 (-1.43)	-.138 (-1.28)	-.199 (-1.98)	-.270 (-2.33)	-.113 (-1.04)	-.208 (-1.78)
Additional Regressors	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
State Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Trend	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
F-stat. on all $\mu_i = 0$[a]	2.74 (.0)	2.05 (.0)	2.74 (.0)	2.69 (.0)								
Sargan's test (One-step)[a]									164.7 (.0)	159.7 (.0)	162.4 (.0)	153.6 (.0)
Sargan's test (Two-step)[a]									21.1 (1.0)	.10 (1.0)	13.7 (1.0)	.0 (1.0)

Note: t-statistics in parentheses.

[a] P-values are given in parentheses.