

# **Do Increased Beer Taxes Reduce Risky Sexual Behavior?**

## **The Evidence from State-Level STD Rates.**

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### **Abstract<sup>3</sup>**

In this paper, we revisit the issue of the effectiveness of increased beer taxes in reducing ‘risky’ sexual behavior as instrumented by two sexually transmitted disease (STD) rates. We use longitudinal state-level data for 1975-1995. We find that the effects of beer taxes on STD rates are sensitive to model specification and estimation method, and are either improbably large in magnitude or statistically insignificant. Hence, we believe that the ‘true’ effects of such taxes on risky sexual behavior are uncertain, and caution against placing undue hope in alcohol taxes as an effective tool to combat risky sexual behavior and the spread of STDs.

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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 ways that may effectively combat those problems. A particularly popular method is to explore whether increased alcohol taxes, which presumably decrease the demand for alcohol via the price effect, have any effects on problem phenomena frequently associated with alcohol use. This method has been applied most frequently to the phenomenon of motor vehicle fatalities. However, recent literature has also begun to explore the effects of alcohol taxes on phenomena like domestic violence, anti-social behavior on college campuses, and ‘risky’ sexual behavior. This study focuses on the last phenomenon, and considers the effects of two alcohol policies on risky sexual behavior as proxied by the rates of two sexually transmitted diseases (hereafter STDs) – gonorrhea and syphilis.

To our knowledge, only one previous study in the economics literature, by Chesson, Harrison and Kassler (2000) has adopted this approach. The results from that study suggest that alcohol taxes are particularly successful in lowering the rates of sexually transmitted disease, which in turn suggests that alcohol taxes are an excellent tool for combating risky sexual behavior. It is this underlying implication of the findings that is probably of real interest from the policy perspective -- for while there are social benefits to reducing these specific STD rates per se, the findings suggest that alcohol taxes can be a tool for combating larger social problems like spread of AIDS, and unwanted pregnancies and the problems in resolving them. Thus, given that the effects (or lack thereof) of alcohol taxes on STD rates have important policy implications, we revisit this issue. We use more extensive data-sets and more general model specifications than that employed by the previous authors. In addition, we use alternate econometric techniques, noticing that the traditional fixed effects and random effects estimators can be inconsistent in the

dynamic panel models. Our results indicate that the significant effects of alcohol taxes on STD rates are rather non-robust, and raise concerns that the large effects found by the previous study might be spurious. Accordingly, we caution against relying overmuch on higher alcohol taxes as an effective tool for combating risky sexual behavior.

## **2. Background**

Social scientists have long been concerned about the effects of government mandated policies on alcohol demand and various negative phenomena associated with excessive alcohol use. Specifically, the role of higher taxes on alcohol consumption has been extensively researched, with many empirical studies presenting findings that support the sensitivity of alcohol demand to higher taxes (for example, Coate & Grossman, 1988; Kenkel, 1993; Cook & Moore, 1994).<sup>4</sup> However, an emerging body of literature is now beginning to challenge many of these findings and contend that many of these results might be affected by omitted variable bias. One important concern is that, if studies are based on cross-sectional data, then they cannot account for unobserved state-specific attributes that influence both the level of alcohol taxes (or prices) and the prevalence of alcohol consumption, thus potentially biasing the effects of the taxes away from zero. The support for this hypothesis appears to be growing. Dinardo and Lemieux (1992) employ Monitoring the Future (MTF) data from 1980-89 and variety of model specifications, and find no evidence that alcohol consumption is affected by alcohol prices per se after inclusion of state level dummies. Mast *et al.* (1999) find a non-effect of beer taxes 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, whereas beer

taxes appear to have a significant and negative effect on alcohol consumption if state fixed effects are excluded, they cease to be statistically significant (and often have the incorrect sign) once the effects are incorporated. This result holds for all drinkers, separately for “moderate” and “heavy” drinkers, and is robust to the inclusion of additional variables. Along parallel lines, recent studies are also challenging earlier findings regarding the efficacy of alcohol taxes in decreasing a very important alcohol related phenomenon – motor vehicle fatalities. Previous studies had suggested that higher alcohol taxes were particularly successful in decreasing motor vehicle fatalities (Saffer & Grossman, 1987; Chaloupka *et al.*, 1993; Ruhm, 1996). However, Dee (1999) finds that beer taxes cease to have any significant effects on state-level motor vehicle fatality rates once state-specific time trends are incorporated in the model. Young and Likens (2000) find that neither the beer tax nor the beer price have significant effects either on overall traffic fatalities or on specifically alcohol-involved fatalities once state and year fixed effects and various other state-level characteristics are included in the model.<sup>5</sup>

With regard to alcohol use and ‘risky’ sexual behavior, it is well-established that there exists a strong associational relationship between the two.<sup>6</sup> Of course, association is not proof of causality, since both alcohol consumption and participation in risky sexual activity (for instance, non-contracepted sexual activity, multiple sexual partners, sex with relative strangers) may be driven by an underlying individual penchant for high-risk or ‘deviant’ behavior.<sup>7</sup> Recent studies

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<sup>4</sup> Studies have also found some evidence of the negative effect of higher alcohol taxes on traffic fatality rates (Saffer & Grossman, 1987; Chaloupka *et al.*, 1993, Ruhm, 1996), domestic violence (cite) and on violence on college campuses (Grossman & Markowitz, 1999).

<sup>5</sup> Mast *et al.* (1999) attempt a vast array of different specifications, and conclude that beer tax effects are highly sensitive to model specifications and omitted variable biases, and have at best weak effects when other factors that may be correlated with the beer tax and affect alcohol consumption are included in the model.

<sup>6</sup> See Rees *et al.* (2001) and Sen (2002) for a brief review of this literature.

<sup>7</sup> It is important to distinguish between association and causality between alcohol use and risky sexual activity from a policy making perspective. Rees *et al.* (2001) argue that if the results are associational and

in the economic literature are now attempting to explore the existence of real causal links between alcohol use and sexual activity, specifically for adolescents, but results from individual level studies appear to be mixed. For example, Rees *et al.* (2001) and Grossman and Markowitz (2002) find that alcohol ceases to have statistically significant effects on the probability of sexual activity by adolescents once the possible endogeneity between these behaviors is controlled for, whereas Sen (forthcoming, 2003) and Hofler *et al.* (2002) find evidence that a causal effect of alcohol use on sexual activity does exist, though it is substantially smaller than the simple associational effect.

The economic literature on alcohol policy and indicators of ‘risky’ or ‘careless’ sexual behavior at the state level is limited. We are aware of only three existing studies, of which two focus on adolescents. Dee (2001) finds that higher minimum legal drinking ages have a negative effect on teen motherhood rates among black adolescents, but not among white adolescents. Sen (2002) finds that increased alcohol taxes have no effects on adolescent birthrates, and very small negative effects on adolescent abortion rates, with the latter result being sensitive to the inclusion of state fixed effects. In contrast, the previously mentioned results from Chesson *et al.* (2000) find that increased beer taxes appear to very substantively reduce STD rates among the overall population,<sup>8</sup> implying that higher alcohol taxes are a particularly powerful deterrent to risky sexual behavior in general. The policy implications of these findings are that higher alcohol

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driven by an underlying penchant for risk-taking behavior, then policies that make obtaining alcohol more difficult might lead risk-takers to substitute other high risk behaviors in place of alcohol use – including more high-risk sexual behavior.

<sup>8</sup> These authors 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. These figures seem unexpectedly high. They say that these may not be ‘ceteris paribus’ results, since states typically accompany increases in beer taxes with simultaneous increases in taxes of other alcoholic beverages. Additionally, these authors also estimate the effects of higher minimum legal drinking ages on STD rates among 15-19 years olds, where they find that an year’s increase in the minimum legal age appears to reduce gonorrhea rates by about 6.5 to 8 percent.

taxes should not only reduce the rates of the two STD rates specifically considered, but could potentially also decrease the incidence of HIV infections and AIDS, unwanted pregnancies, the need for abortions, and premature motherhood. However, specifically in light of the recent developments in the literature on motor vehicle fatalities (a phenomenon that should be very closely related to alcohol consumption), caution and further analysis on the effects of alcohol policy on STDs seem advisable before policy recommendations are made.

### ***Empirical Model***

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.

$$\log(R_{it}) = \mathbf{a}_i + \mathbf{g}_t + \mathbf{d} \log(R_{i,t-1}) + X_{it}'\boldsymbol{\gamma} + \mathbf{b} Tax_{it} + u_{it}, \quad i = 1, \dots, N; t = 1, \dots, T. \quad (1)$$

where  $R_{it}$  is the STD rate. This model seems appropriate because STD rates are communicable diseases, so it is logical to hypothesize that current prevalence of the disease will in part be dependent on past prevalence.<sup>9</sup> Here,  $\mathbf{a}_i$  and  $\mathbf{g}_t$  capture state-specific and time-specific fixed effects;  $Tax_{it}$  is the per-gallon beer tax in 1998 dollars; and  $u_{it}$  is the error term.  $X_{it}$  is a vector of state and year specific observables that may potentially impact  $R_{it}$ , and will be discussed in more detail in the next section.

Note that the estimation of this model is complicated by its dynamic structure. The inclusion of year and state dummies is necessary to control for the bias arising from unobservables that may affect both the current (state) beer tax level and the STD rate. Including those dummies and

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<sup>9</sup> Such dynamic models have been popular in estimating a partial adjustment or habit-persistence model (see Houthakker & Taylor, 1970, Baltagi *et al.*, 2000, among many others). The persistent effect is also evident in our case.

applying the ordinary least squares method amounts to doing the within transformation which accounts for state and year specific fixed effects. While the within estimator controls for unobserved heterogeneity, it can still pose a problem. It is now well known in the literature that, in case of dynamic models, the within estimator (as well as random effects estimators) is biased and inconsistent (see, for example, Nickell, 1981; Kiviet, 1995; Baltagi & Griffin, 1997).<sup>10</sup> The bias problem becomes negligible only when  $T$  is large. Otherwise results from standard fixed effect models may be somewhat suspect.

Returning to the model specification, we maintain the possibility that, apart from unobservables that are invariant within state or invariant across all states for a given year, there is also the possibility that certain unobservables within states change over time in ways that are different from other states. To capture this, we incorporate an interaction term of state dummies and the time trend, and estimate a second model. As discussed in the previous section, Dee (1999) and others demonstrate evidence that failure to control for the state-specific trends can be misleading in other applications.<sup>11</sup> Hence, the models can be revised as:

$$\log(R_{it}) = \mathbf{a}_i + \mathbf{g}_t + t \cdot \mathbf{a}_i + \mathbf{d} \log(R_{i,t-1}) + \mathbf{b} Tax_{it} + X_{it}'\boldsymbol{\gamma} + u_{it}, \quad i = 1, \dots, N; t = 1, \dots, T. \quad (2)$$

where  $t \cdot \mathbf{a}_i$  are the state-specific time trends. All results are presented in the following section.

### 3. Data, Estimation Results & Discussion.

In this section, we empirically investigate the effect of beer or liquor taxes on STD rates. Our data set covers the period of 1975-1995. We obtain the data for STD rates per 100,000

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<sup>10</sup> This occurs due to the correlation of  $v_{it}$ , (where  $v_{it} = \mathbf{a}_i + \mathbf{g}_t + u_{it}$ ) with  $R_{i,t-1}$  and the transformed lagged dependent variable is still correlated with the error term. This endogeneity problem induces bias not only in the estimated coefficient of the lagged dependent variable, but in the estimated coefficients of the other independent variables including the primary variable of interest,  $Tax_{it}$  as well (see Nickell, 1981, for calculations of magnitudes of the respective biases).

population by state directly from the Centers for Disease Control and Prevention. We also use the data on per gallon beer and liquor taxes published by Distilled Spirits Council of the United States (DISCUS), transformed using June 1998 price levels.<sup>12</sup>

We also include a vector of other state characteristics,  $X_{it}$ , which are time variant and may not be captured fully either by state and year fixed effects or by state-specific trends. All monetary values are transformed to June 1998 price levels. The first observable included is per capita state income. This is important because health (specifically, avoiding STDs) may be a normal good, and because a \$1 per gallon tax on alcohol is unlikely to mean the same thing when the state per capita income is \$28,000 versus when it is \$18,000. If beer taxes are correlated with state per capita income, and if increases in per capita income result in changes in STD rates, then omitting per capita income might make it appear as if these changes were attributable to the beer taxes. Experimentation with alternate model specifications reveal that the relationship between STD rates and per capita income is non-linear, in that a higher per-capita income appears to decrease STD rates but does so at a decreasing rate. Hence, we include both per capita income and its square in our equation. We also include in  $X_{it}$ , the percentage of state population aged between 15-19 years (teenperc), because surveillance reports from the Centers for Disease Control and Prevention indicate that STD rates are higher among adolescents, attributing the phenomenon to the greater likelihood of adolescents having multiple sexual partners, engaging in unprotected intercourse, and exercising less discretion when choosing partners in comparison to adults. 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 potential policies are welfare generosity and

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<sup>11</sup> Note that if existing time trends are ignored, then it might potentially cause autocorrelation in the error term.

the availability of Medicaid funding for abortion. Some studies in the economic literature indicate that state welfare generosity affects not just pregnancy-resolution but also the initial occurrence of pregnancies (An *et al.*, 1993; Lundberg & Plotnick, 1995), and a recent study by Levine (2001) suggests that state welfare generosity may directly affect sexual activity and non-contracepted sexual activity among young people. Indirect evidence that Medicaid funding restrictions may affect the initial occurrence of pregnancies is provided by Levine *et al.* (1996), Kane and Staiger (1996) and Matthews *et al.* (1997). Since behaviors leading to the occurrence of accidental pregnancies and those leading to STD infections are likely to be highly correlated, we include in  $X_{it}$  the inflation-adjusted maximum AFDC funding available to a family of three per month (maxafdc) and the number of years since the state restricted Medicaid funding for terminating non-life threatening, non-rape pregnancies (medrestlngth). The latter figure always takes the value of '0' for states that have not imposed such restrictions. We estimate all models with and without the vector of variables in  $X_{it}$ . We also estimate the models after substituting the lagged beer tax in place of the current beer tax, to account for the fact that there may be a time-lag between tax changes getting translated into price changes, as well as the possibility that the demand for alcohol may be more elastic in the 'long run'. As a further robustness test, we also estimate the models after including some additional state alcohol-policy variables in addition to beer taxes and the vector  $X_{it}$ . These include the state minimum legal drinking age,<sup>13</sup> a binary indicator of whether the state sets the maximum, legal blood alcohol limit for driving at 0.08 (as opposed to 0.1 or higher), and a binary indicator for whether the state has an administrative

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<sup>12</sup> We are obliged to Harrell Chesson for generously sharing the nominal alcohol tax data from the Distilled Spirits Council of the United States (DISCUS).

<sup>13</sup> This policy should affect STD rates primarily among underage drinkers. However, since STD rates are among the highest in those age groups, reduction in STD rates among them could translate into noticeable reductions in the rates for the over-all population.

license revocation law.<sup>14</sup> If there exists any correlation between state beer taxes and other state alcohol policies, then the omission of those policies may introduce bias in the beer tax estimates.

We present results for both gonorrhea and syphilis rates. However, the readers should be cautioned that results from syphilis rates may be relatively unreliable. This is due to the fact that syphilis rates are far lower than gonorrhea rates; hence small changes in the number of cases can sometimes translate into very large percentage changes, making coefficient estimates volatile. Also, syphilis rates are very unevenly distributed, with many states having a very low syphilis incidence. In fact, in recent years more than half of the nation's new syphilis cases have been concentrated in just 31 of the nation's 3,115 counties.

Tables 1a and 1b present results from estimating regular fixed effects models (where results may be subject to the endogeneity problems arising from the lagged dependent variable) for gonorrhea and syphilis rates, respectively. All models are estimated with and without the vector  $X_{it}$  and additional alcohol policies, as well as with and without the state-specific trends.<sup>15</sup> Additionally, we present the results from one specification where one-year lagged taxes are substituted for current taxes. Parallel results with lagged taxes for the other specifications are available upon request.

With regards to the other state-level observables, the percentage of population aged 15-19 (teenperc) has a significant and positive impact on gonorrhea rates, though not on syphilis rates. Increases in per capita income appear to reduce STD rates in models where state-specific trends are included, though they do so at a decreasing rate, with the minima being reached at a little less

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<sup>14</sup> This means that a person's driving license can be suspended or revoked as soon as a drunk-driving charge has been filed against him/her, even before the court has ruled on the case.

<sup>15</sup> F-tests find that the year fixed effects, state fixed effects, and state-trends are each jointly significant at the 5 percent level. This suggests that all three should be included in the models.

than \$23,000.<sup>16</sup> Higher levels of AFDC benefits are associated with higher gonorrhea rates, though the result is statistically significant only in the absence of state-specific trends.<sup>17</sup> Among the other alcohol policies included, license revocation laws seem to have a negative and significant effect on gonorrhea rates in models where state-specific trends are included. However, we are cautious about the interpretation given the fragility of this result. It neither holds for gonorrhea rates when state-specific trends are excluded, nor holds for syphilis rates in any of the model specifications.

We next turn to estimating the model with methods deemed more appropriate when there are lagged dependent variables present. As discussed previously, there is substantial evidence in the econometric literature that using standard fixed effects methods to estimate dynamic panel models having a lagged dependent variable as a regressor can lead to biased and inconsistent estimators unless the number of time periods,  $T$ , is sufficiently large. While the bias is negligible when  $T$  is sufficiently large, whether a  $T$  of 15 is indeed ‘sufficiently large’ is a debatable question. Specifically, our results so far, using standard fixed effects methods, indicate that alcohol taxes have statistically insignificant effects on the STD rates once state-trends are included. The question remains about whether these results would continue to hold if we employ estimation techniques that are more appropriate for dynamic models with lagged dependent variables. Accordingly, we also estimate the model using such techniques. The source of the

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<sup>16</sup> This suggests that initially, as income increases, people reduce their ‘consumption’ of the type of sexual activity that may lead to STD infections. However, beyond a certain level of income, such sexual activity apparently reverts to being a ‘normal good’, and thus STD rates may actually be positively affected by increases in per capita income.

<sup>17</sup> We would like to emphasize that we do not immediately make the conclusion that reducing welfare benefits would successfully reduce STD rates. Not only are AFDC benefits insignificant once state-specific trends are incorporated, but we believe that before making any definitive conclusions about the impact of welfare benefits on STD rates, one would have to account for Medicaid benefits and availability of health care in the state, and include alternate measures of welfare generosity other than just the maximum monthly AFDC payments for a particular family size.

problem is that the regressor using the lagged dependent regressor is endogenous by construction. However, there exist a number of ‘instrumental variables,’ which are orthogonal to the endogenous lagged dependent variable, and they can be employed to circumvent the endogeneity issue. We opt to use Arellano and Bond’s (1991) GMM estimation method as well as the Anderson & Hsiao’s (1981) FD-IV method. Both methods utilize instruments involved in the dynamic panel data model after first differencing the variables in equation (2). Note that while the GMM estimator utilizes more instrument variables, both estimators are consistent.

Estimation results from using the Anderson & Hsiao’s (1981) FD-IV method are presented in Table 2. The results show that in all cases beer taxes do not significantly affect any of the gonorrhoea and syphilis rates. In all cases, the coefficients of the beer tax variable are insignificant ( $p$ -values  $> 10\%$ ). This is so, regardless of whether any additional time variant regressors, year dummies, or state-specific trends are included. When the lagged tax variable is used, the results show the same pattern: the beer tax has no significant effects on the STD rates. Note that the state dummy variables are differenced away.

Next, we consider the Arellano and Bond GMM estimator that utilizes the large instrument matrix derived from the orthogonality conditions. Results from the Arellano-Bond estimations for both current and lagged beer taxes and liquor taxes are presented in Table 3. Generally, the Arellano-Bond GMM method reveals the same pattern as the traditional fixed effects results. We find that current beer taxes appear to have a negative and significant effect when state-specific trends are excluded, but the effect is disconcertingly large. However, after the inclusion of state-specific trends, current beer taxes fail to be significant at the 10 percent level (the only

exception being syphilis where lagged taxes are used). A similar pattern is found when the lagged beer taxes are used.<sup>18</sup>

The sensitivity of the beer tax results to the inclusion of state-trends poses a quandary. One interpretation is that beer taxes do not, in fact, have any real effects on STD rates, and the effects in the models without state-trends are ‘spurious’, resulting from the bias due to omitted variables. However, the other interpretation is that the inclusion of state-specific trends in addition to state and year fixed effects is simply a case of ‘over-fitting’ that reduces the precision of estimation results by decreasing degrees of freedom. We make an attempt to circumvent this problem by reconsidering the effect of the taxes after substituting region-specific fixed effects based on the nine sub-regions of U.S. identified in various issues of the Statistical Abstracts of the United States in place of state fixed effects.<sup>19</sup> States within each sub-region may share certain common unobserved characteristics, and sub-region specific dummies and sub-region specific trends will control for how such unobservables change over time, while adding fewer variables to the model (the results are presented in the appendix). However, not only do we continue to find insignificant effects of beer taxes on STD rates after inclusion of sub-region effects and sub-region specific trends, but now we find that the effects are insignificant even when the trends are excluded. This holds, regardless of whether or not the other state-specific observables are

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<sup>18</sup> We also attempt alternate instrumental variables methods, like that of the error-components two-stage least squares (RE-2SLS) estimator of Baltagi (1981) that treats the state-specific effects as random. We find that alcohol taxes perform even more poorly in terms of statistical significance under those methods than the Arellano-Bond method. Other extended methods by Arellano and Bover (1995), 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.

<sup>19</sup> The nine sub-regions are: New England (ME, NH, VT, MA, RI, CT), Middle Atlantic (NY, NJ, PA), East North Central (OH, IN, IL, MI, WI), West North Central (MN, IA, MO, ND, SD, NE, KS), South Atlantic (DE, MD, DC, VA, WV, NC, SC, GA, FL), East South Central (KY, TN, AL, MS), West South Central (AR, LA, OK, TX), Mountain (MT, ID, WY, CO, NM, AZ, UT, NV) and Pacific (WA, OR, CA, AK, HI).

controlled for in the model.<sup>20</sup> However, we do not venture to speculate about whether results obtained using sub-region fixed effects and trends ought to be preferred over those obtained using state fixed effects and trends.

While the preferred specification of the model must be a matter of debate, a way to gauge the reliability of the results pertaining to beer taxes in models with state and year fixed effects only is to consider the *magnitudes* of the obtained effects and the feasibility of those magnitudes. Note that in the fixed effects models, a \$1 increase in beer taxes appears to reduce gonorrhea rates by about 11 percent, whereas in the Arellano-Bond GMM models, the effects appear to be at least 30 percent. The inflation-adjusted mean beer tax (federal and state) in our sample is about 90 cents per gallon. Accordingly, based on the mean tax value, the elasticity of gonorrhea rates to taxes appears to range between -0.10 and -0.27. Relying on Dee's (1999) assertion that beer taxes on average make up about 10% of the total beer price, this suggests that the elasticity of STD rates with respect to beer *prices* range between -1.00 and -2.7. The existing literature on alcohol-use finds that the price elasticity of alcohol is about -0.5 to -1.6 for all alcoholic beverages, and at best -0.3 for beer using aggregate level data.<sup>21</sup> Among studies using individual level data, early research (surveyed by Ornstein & Levy, 1983) found the price elasticity of beer demand to range between -1.39 to 0.01. More recent studies find average price elasticity of beer to be about -0.8 (Heien & Pompelli, 1989), and alcohol in general about -0.8 (Mannings *et al*, 1995) to -1.1 (Atkinson, 1990). It seems logical to surmise that not all of those at risk of being

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<sup>20</sup> This is one place where our results using the specification used by Chesson *et al*. seem to differ from theirs. They state that they found their results remained intact when they reduced state dummy variables by combining states by region. We attempted an alternate specification of regions, dividing the states simply into Northeast, North Central, South and West. Beer tax effects continued to be insignificant, even when all variables in  $X_{it}$  were excluded.

<sup>21</sup> One good summary of the literature on price elasticities of alcohol is available from Manning *et al* (1995).

infected by STDs participate in sexual activity while under the influence. Hence, it seems unrealistic that the apparent responsiveness of gonorrhea rates to beer prices (taxes) would be equal or greater than the higher-level estimates of the responsiveness of alcohol or beer consumption to prices. The responsiveness of syphilis rates is far larger and quite obviously illogical, perhaps simply due to the shortcomings of the nature of syphilis data mentioned earlier.

One way to gauge the feasibility of the above results is to estimate a similar model for the responsiveness of per-capita alcohol consumption to beer taxes. Since alcohol is potentially an addictive or habit-forming substance, current consumption levels are likely to be positively affected by past consumption levels; hence the lagged-dependent variable models are appropriate here too. Accordingly, we now re-estimate the models using (log) per-capita alcohol consumption in place of (log) STD rates. Longitudinal data on apparent per-capita alcohol consumption, computed based on alcoholic beverage sales data and the population aged 14 or above in the state, is readily available from the National Institute on Alcohol Abuse & Alcoholism. Estimation results are presented in Table 4 and only include models that control for state and year fixed effects.<sup>22</sup> Beer taxes were found to have statistically insignificant effects in all cases where state-specific trends were additionally included. Those results are available upon request.

Perhaps the most noticeable feature here is that the Arellano-Bond GMM estimator indicates that beer taxes do not have statistically significant effects on per-capita alcohol consumption. This is consistent with the (previously mentioned) findings in the recent literature that ‘tax effects’ cease to be significant when other factors (including state unobservables) are controlled

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<sup>22</sup> We present results from the standard fixed effects model and the Arellano-Bond GMM model. In the Anderson-Hsiao model, beer taxes were not found to significantly affect beer consumption in any specification.

for. In the regular fixed effects models, the beer tax effects appear to be significant. However, regardless of the method used, the *magnitude* of the tax effect -- namely, a \$1 increase in per gallon beer tax -- is about 0.03. This is only a small fraction of what the apparent effect of beer taxes on STD rates seems to be, thus giving reason to suspect that those effects are spurious. Since beer taxes can affect STD rates only via reducing the level of alcohol use and accordingly reducing the likelihood of engaging in 'risky' sexual behavior while under the influence, there seems no feasible explanation for how the true effects of beer taxes on STD rates can be so much larger than the effects of those taxes on alcohol use to begin with!<sup>23</sup>

It is of interest to summarize how our results regarding beer taxes and STD rates compare with those of Chesson *et al.* (2000). Recall that they use a shorter panel, for the years 1981-95 only, estimate all models using regular fixed effects, and do not explicitly control for any state-level observables other than the taxes. They find that in models where state and year fixed effects are controlled for, a \$1 increase in beer taxes appeared to reduce gonorrhea rates by 25.4 percent and syphilis rates by 93.3 percent, both results being significant at the 10 percent level or better. Thus the magnitudes of their estimated effects are twice as large as what we find using parallel techniques and data from 1975-1995. Another difference is their finding that beer taxes appear to have a significantly negative effect on gonorrhea rates even after including state-specific trends, whereas we find no evidence of significant effects after including the trends. Additionally, they report that robustness tests where regional fixed effects were substituted for state fixed effects left their results intact, whereas we systematically find that substituting regional effects in place of state effects result in the effects of the taxes becoming insignificant.

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<sup>23</sup> The only hypothesis that would allow these contradictory results to co-exist is that beer taxes have a disproportionately large effect on alcohol use by those groups who are specifically at risk of STD

They do not report any analysis that assesses the apparent effects of beer taxes on STD rates versus on per-capita alcohol consumption itself; hence, we cannot make any comparisons regarding those results.

#### **4. Conclusion.**

The purpose of our study has been to assess whether increased beer taxes are effective in reducing risky sexual behavior among the population by investigating the effects of such taxes on two STD rates. Using data for 1975-1995 and a variety of model specifications and estimation techniques, we find that taxes appear to have negative and significant effects in models that control for state and year fixed effects only, with the exception of the Anderson-Hsiao model which exhibits no significant effects in all cases. However, we also find that the effects cease to be significant when state-specific trends are incorporated or when state effects are substituted for by regional effects. Perhaps even more disconcertingly, we find that the apparent negative effects of beer taxes after controlling for state and year fixed effects only are far larger than the corresponding effects of beer taxes on per capita alcohol consumption itself. This last finding suggests that these negative effects are likely to be spurious, possibly resulting from some unaccounted omitted variable bias.

Risky sexual behavior and its consequences continue to be a matter of serious concern in this country. Recent reports from the Centers for Disease Control and Prevention regarding a recent upsurge in syphilis rates and from the Alan Guttmacher Institute regarding an increase in demand for abortions among low income women, emphasize the continued need for finding effective tools to combat the negative effects of risky sexual behavior. However, our findings lead us to

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infections. Testing that hypothesis is beyond the capability of any study that uses state-level data, but may be a task that researchers with access to appropriate individual level data may pursue.

caution against relying on beer taxes as an effective policy tool for combating risky sexual behavior and its attendant negative consequences like the spread of STDs.

Note that the failure to find reliable evidence of increased beer taxes reducing STD rates do not automatically imply that there is no causal relationship between alcohol use and risky sexual behavior. It might equally imply the failure of beer taxes or prices to influence the demand for alcohol adequately. For example, Mannings *et al.* (1995) finds that both light and heavy drinkers have much lower price elasticities than moderate drinkers. Under this scenario, it could be conjectured that if either light (novice) drinkers or heavy (problem) drinkers were the ones most likely to engage in risky sexual activity while “under the influence”, then increased beer taxes would fail to influence such activity (and its consequences) primarily due to its failure to influence drinking behavior in the first place.

Various directions for future research are suggested. It is unclear whether revisiting the issue of STD rates and beer taxes with even longer panels of data would necessarily clarify the relationship between the two any further. However, it may be of interest to consider the effects of beer taxes on other indicators of risky or careless sexual activity such as abortion rates, for instance. It may also be of interest to investigate in depth the effects of other alcohol policies, like BAC limits, license revocation for DUI, and mandatory jail sentences for DUI convictions, on indicators of risky sexual activity. Finally, research with individual level data on the ‘real’ relationship between alcohol use and sexual activity that looks beyond just the adolescent population is also called for.

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**Table 1a: The Effect of Beer Taxes on Gonorrhea Rates  
(FE Models, Not Correcting for Endogeneity)**

<b>Variables</b>	<b>Model FE 1</b>	<b>Model FE 2</b>	<b>Model FE 3</b>	<b>Model FE 4</b>	<b>Model FE 5</b>	<b>Model FE 6</b>	<b>Model FE 7</b>	<b>Model FE 8</b>
Lagged STD	0.919 (66.9)	0.613 (22.6)	0.908 (61.3)	0.599 (21.9)	0.905 (58.45)	0.592 (21.56)	0.905 (58.21)	0.590 (21.38)
Tax	-0.123 (-2.48)	-0.024 (-0.21)	-0.114 (-2.03)	0.035 (0.30)	-0.106 (-1.83)	0.023 (0.20)		
Tax (lagged 1)							-0.093 (-1.75)	0.048 (0.42)
Per Cap Income			-0.110 (-0.78)	-0.382 (-2.19)	-0.103 (-0.72)	-0.360 (-2.07)	-0.097 (-0.68)	-0.367 (-2.10)
Per Cap Income- Squared			0.004 (1.37)	0.012 (2.72)	.003 (1.26)	0.011 (2.51)	.003 (1.21)	0.011 (2.55)
MaxAFDC			0.024 (1.85)	0.025 (1.37)	0.021 (1.67)	0.022 (1.23)	0.021 (1.63)	0.022 (1.24)
Teenperc			0.015 (2.00)	0.016 (1.87)	0.013 (1.78)	0.014 (1.68)	0.013 (1.79)	0.015 (1.65)
Medrestlngh			0.002 (1.12)	-0.013 (-1.19)	0.002 (1.11)	-0.013 (-1.20)	0.002 (1.16)	-0.013 (-1.19)
MLDA					0.003 (0.38)	-0.005 (-0.50)	0.002 (0.27)	-0.004 (-0.43)
BAC 0.08					-0.014 (-0.47)	0.015 (0.40)	-0.014 (-0.79)	0.015 (0.41)
License Revocation					-0.014 (-0.80)	-0.052 (-2.45)	-0.016 (-0.53)	-0.052 (-2.44)
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Trend	No	Yes	No	Yes	No	Yes	No	Yes
R <sup>2</sup>	0.982	0.985	0.982	0.986	0.982	0.986	0.982	0.986
Adj-R <sup>2</sup>	0.981	0.983	0.981	0.984	0.980	0.984	0.981	0.984
F-statistic	718.2	488.7	675.5	477.0	648.7	467.5	648.6	467.19
N	1007	1007	1007	1007	1007	1007	1006	1006

t-statistics given in parenthesis.

The dependent variable is log of gonorrhea rates. All monetary variables are measured in 1998 dollars.

**Table 1b: The Effect of Beer Taxes on Syphilis Rates  
(FE Models, Not Correcting for Endogeneity)**

<b>Variables</b>	<b>Model FE 1</b>	<b>Model FE 2</b>	<b>Model FE 3</b>	<b>Model FE 4</b>	<b>Model FE 5</b>	<b>Model FE 6</b>	<b>Model FE 7</b>	<b>Model FE 8</b>
Lagged STD	0.707 (28.1)	0.550 (18.4)	0.689 (26.8)	0.517 (16.9)	0.682 (26.49)	0.517 (16.8)	0.679 (26.17)	0.517 (16.7)
Tax	-0.456 (-2.95)	-0.062 (-0.17)	-0.497 (-2.88)	0.002 (0.00)	-0.455 (-2.57)	0.04 (0.12)		
Tax (lagged 1)							-0.462 (-2.81)	-0.09 (-0.42)
Per Cap Income			-0.213 (-0.48)	-1.30 (-2.30)	-0.072 (-0.16)	-1.27 (-2.25)	-0.101 (-0.23)	-1.26 (-2.23)
Per Cap Income- Squared			0.013 (1.40)	0.048 (3.40)	0.01 (1.00)	0.046 (3.28)	0.01 (1.08)	0.046 (3.25)
MaxAFDC			-0.013 (-0.32)	-0.052 (-0.90)	-0.027 (-0.66)	-0.058 (-1.00)	-0.029 (-0.72)	-0.062 (-1.06)
Teenperc			0.035 (1.51)	-0.046 (-1.59)	0.031 (1.31)	-0.050 (-1.69)	0.032 (1.35)	-0.057 (-1.72)
Medrestlngh			0.021 (3.29)	-0.032 (-0.87)	0.019 (3.08)	-0.035 (-0.95)	0.019 (3.07)	-0.035 (-0.97)
MLDA					0.002 (0.08)	0.005 (0.15)	0.00001 (0.00)	0.007 (0.25)
BAC 0.08					-0.258 (-2.83)	-0.110 (-0.90)	-0.265 (-2.92)	-0.104 (-0.86)
License Revocation					0.010 (0.18)	-0.058 (-0.84)	0.012 (0.22)	-0.058 (-0.85)
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Trend	No	Yes	No	Yes	No	Yes	No	Yes
R <sup>2</sup>	0.900	0.912	0.902	0.914	0.903	0.914	0.903	0.914
Adj-R <sup>2</sup>	0.893	0.900	0.894	0.902	0.894	0.902	0.895	0.902
F-statistic	117.0	74.6	111.4	73.2	107.87	71.43	107.93	71.36
N	992	992	992	992	992	992	991	991

t-statistics given in parenthesis.

The dependent variable is log of syphilis rates. All monetary variables are measured in 1998 dollars.

**Table 2: The Effect of Beer Taxes on Gonorrhea Rates & Syphilis Rates  
(Anderson-Hsiao FD-IV Estimation Results)**

<b>Gonorrhea Rate Results</b>								
<b>Variables</b>	<b>FD-IV 1</b>	<b>FD-IV 2</b>	<b>FD-IV 3</b>	<b>FD-IV 4</b>	<b>FD-IV 5</b>	<b>FD-IV 6</b>	<b>FD-IV 7</b>	<b>FD-IV 8</b>
Lagged STD	0.444 (0.56)	1.423 (1.24)	0.420 (0.52)	1.430 (1.15)	0.419 (0.47)	1.36 (1.21)	0.408 (0.42)	1.33 (1.25)
Tax	-0.141 (-0.59)	-0.618 (-0.17)	-0.120 (-0.48)	-0.020 (-0.05)	-0.015 (-0.69)	-0.138 (-0.36)		
Tax (lagged 1)							-0.130 (-0.42)	0.015 (0.04)
$X_{it}$ Vector	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Other Alcohol Policies	No	No	No	No	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Effects	No	No	No	No	No	No	No	No
State Trend	<b>No</b>	Yes	<b>No</b>	Yes	<b>No</b>	Yes	<b>No</b>	Yes
Chi-square overall sig.	150.2	85.1	168.38	88.26	177.6	97.32	177.1	99.46
Corr( $u_i$ , $X_b$ )	0.779	-0.827	0.680	-0.836	0.660	-0.809	0.650	-0.796
N	906	906	906	906	906	906	905	905
<b>Syphilis Rate Results</b>								
<b>Variables</b>	<b>FD-IV 1</b>	<b>FD-IV 2</b>	<b>FD-IV 3</b>	<b>FD-IV 4</b>	<b>FD-IV 5</b>	<b>FD-IV 6</b>	<b>FD-IV 7</b>	<b>FD-IV 8</b>
Lagged STD	0.074 (0.47)	0.141 (0.95)	0.073 (0.49)	0.138 (0.97)	0.075 (0.49)	0.138 (0.98)	0.067 (0.44)	0.130 (0.92)
Tax	-0.367 (-0.65)	-0.003 (-0.00)	-0.356 (-0.62)	0.103 (.014)	-0.216 (-0.37)	0.286 (0.39)		
Tax (lagged 1)							-0.084 (-1.54)	-0.522 (-0.76)
$X_{it}$ Vector	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Other Alcohol Policies	No	No	No	No	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Effects	No	No	No	No	No	No	No	No
State Trend	<b>No</b>	Yes	<b>No</b>	Yes	<b>No</b>	Yes	<b>No</b>	Yes
Chi-square overall sig.	97.6	110.6	108.2	122.2	111.54	125.45	115.1	125.48
Corr( $u_i$ , $X_b$ )	0.220	-0.955	0.125	-0.968	0.136	-0.968	0.011	-0.983
N	888	888	888	888	888	888	887	887

z-statistics given in parenthesis.

The dependent variable is log of gonorrhea or syphilis rates. All monetary variables are measured in 1998 dollars.

**Table 3: The Effect of Beer Taxes on Gonorrhea Rates & Syphilis Rates  
(Arellano-Bond GMM Estimation Results)**

<b>Gonorrhea Rate Results</b>								
<b>Variables</b>	<b>GMM 1</b>	<b>GMM 2</b>	<b>GMM 3</b>	<b>GMM 4</b>	<b>GMM 5</b>	<b>GMM 6</b>	<b>GMM 7</b>	<b>GMM 8</b>
Lagged STD	0.874 (40.5)	0.626 (16.6)	0.816 (32.1)	0.572 (15.0)	0.799 (29.25)	0.571 (14.91)	0.798 (28.49)	0.565 (14.72)
Tax	-0.432 (-3.79)	-0.166 (-0.99)	-0.338 (-2.49)	-0.020 (-0.12)	-0.323 (-2.40)	-0.021 (-0.13)		
Tax (lagged 1)							-0.324 (-2.54)	-0.053 (-0.42)
<i>Xit</i> Vector	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Other Alcohol Policies	No	No	No	No	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Effects	No	No	No	No	No	No	No	No
State Trend	<b>No</b>	Yes	<b>No</b>	Yes	<b>No</b>	Yes	<b>No</b>	Yes
Chi-square overall sig.	2,728	3,986	2,908	4,256	2957	4608	2947	4615
N	956	956	956	956	956	956	955	955
<b>Syphilis Rate Results</b>								
<b>Variables</b>	<b>GMM 1</b>	<b>GMM 2</b>	<b>GMM 3</b>	<b>GMM 4</b>	<b>GMM 5</b>	<b>GMM 6</b>	<b>GMM 7</b>	<b>GMM 8</b>
Lagged STD	0.546 (14.1)	0.525 (13.3)	0.509 (12.3)	0.495 (12.2)	0.506 (12.21)	0.491 (12.19)	0.499 (12.05)	0.476 (11.88)
Tax	-1.250 (-3.28)	-0.475 (-0.81)	-1.332 (-3.19)	-0.700 (-1.2)	-1.028 (-2.42)	-0.706 (-1.18)		
Tax (lagged 1)							-1.456 (-3.68)	-1.200 (-2.05)
<i>Xit</i> Vector	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Other Alcohol Policies	No	No	No	No	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Effects	No	No	No	No	No	No	No	No
State Trend	<b>No</b>	Yes	<b>No</b>	Yes	<b>No</b>	Yes	<b>No</b>	Yes
Chi-square overall sig.	524.5	790.2	565.9	829.2	575	849		862
N	939	939	939	939	939	939	938	938

z-statistics given in parenthesis.

The dependent variable is log of gonorrhea or syphilis rates

**Table 4: The Effects of Beer Taxes on Per-Capita Alcohol Consumption.**

<b>OLS Results</b>								
<b>Variables</b>	<b>Model 1</b>	<b>Model 2</b>	<b>Model 3</b>	<b>Model 4</b>	<b>Model 5</b>	<b>Model 6</b>	<b>Model 7</b>	<b>Model 8</b>
Lagged Per capita alcohol	0.784 (38.74)		0.718 (32.80)	0.479 (15.95)	0.712 (32.17)		0.712 (32.08)	
Tax	-0.039 (-3.78)		-0.033 (2.96)	0.019 (0.83)	-0.032 (-2.78)			
Tax (lagged 1)							-0.030 (-2.90)	
$X_{it}$ Vector	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Other Alcohol Policies	No	No	No	No	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Effects	No	No	No	No	No	No	No	No
State Trend	No	Yes	No	Yes	No	Yes	No	Yes
N	956	956	956	956	956	956	955	955
<b>Arellano-Bond GMM Results</b>								
<b>Variables</b>	<b>GMM 1</b>	<b>GMM 2</b>	<b>GMM 3</b>	<b>GMM 4</b>	<b>GMM 5</b>	<b>GMM 6</b>	<b>GMM 7</b>	<b>GMM 8</b>
Lagged Per capita alcohol	0.813 (26.28)		0.668 (18.71)		0.654 (18.30)		0.655 (18.45)	
Tax	-0.033 (-1.39)		-0.027 (-1.03)		-0.029 (-1.11)			
Tax (lagged 1)							-0.023 (-0.96)	
$X_{it}$ Vector	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Other Alcohol Policies	No	No	No	No	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Effects	No	No	No	No	No	No	No	No
State Trend	No	Yes	No	Yes	No	Yes	No	Yes
N	939	939	939	939	939	939	938	938

## Appendix:

**Table A.1: Alcohol Tax Effects After Omitting State Effects and Substituting Sub-Region Effect**

Variables	Model FE 1	Model FE 2	Model FE 3	Model FE 4	Model FE 5
Lagged STD	0.987 (103.7)	0.994 (115.0)	0.977 (100.4)	0.999 (131.6)	0.992 (126.2)
Tax	0.005 (0.25)	-0.004 (-0.21)	0.000 (0.01)	-0.005 (-0.25)	-0.013 (-0.57)
Per Cap Income	-0.090 (0.82)	0.115 (1.07)	0.064 (0.56)		0.093 (0.83)
Per Cap Income-Squared	-0.001 (-0.28)	-0.001 (-0.65)	0.000 (0.09)		-0.001 (-0.46)
MaxAFDC	-0.003 (-0.36)	0.001 (0.17)	-0.010 (-1.40)		-0.001 (-0.18)
Teenperc	0.013 (1.87)	0.013 (2.04)	0.014 (2.39)		0.021 (4.89)
Medrestlngh	-0.001 (-0.35)	0.001 (0.54)	-0.001 (-0.43)		-0.000 (-0.16)
Year Effects	Yes	Yes	No	Yes	No
Regional Effects	Yes	Yes	Yes	Yes	Yes
Regional Trend	No	Yes	Yes	Yes	No
R <sup>2</sup>	.9810	.9808	.9780	.9808	.9778
Adj-R <sup>2</sup>	.9802	.9802	.9775	.9801	.9774
F-statistic	1,184	1,464	1,820	1,338	2,906
N	1,007	1,007	1,007	1,007	1,007

t-statistics given in parenthesis.

The dependent variable is log of gonorrhea rates. All monetary variables are measured in 1998 dollars.

**Table A.2.: The Effect of Beer Taxes on Syphilis Rates (FE with Regional Effects)**

Variables	Model FE 1	Model FE 2	Model FE 3	Model FE 4	Model FE 5
Lagged STD	0.869 (52.2)	0.888 (55.4)	0.860 (50.3)	0.899 (60.7)	0.897 (56.4)
Tax	0.011 (0.16)	-0.055 (-0.81)	0.007 (0.11)	-0.027 (-0.43)	-0.081 (-1.17)
Per Cap Income	0.248 (0.72)	0.270 (0.79)	0.286 (0.81)		0.252 (0.72)
Per Cap Income-Squared	0.001 (0.09)	-0.000 (-0.03)	-0.000 (-0.01)		-0.002 (-0.23)
MaxAFDC	-0.059 (-2.69)	-0.043 (-2.04)	-0.076 (-3.40)		-0.031 (-1.54)
Teenperc	0.032 (1.49)	0.042 (2.04)	-0.017 (-0.92)		0.041 (3.21)
Medrestlngth	-0.003 (-0.58)	0.006 (1.41)	-0.004 (-0.77)		-0.001 (-0.22)
Year Effects	Yes	Yes	No	Yes	No
Regional Effects	Yes	Yes	Yes	Yes	Yes
Regional Trend	No	Yes	Yes	Yes	No
R <sup>2</sup>	.8834	.8907	.8817	.8912	.8771
Adj-R <sup>2</sup>	.8887	.8868	.8788	.8870	.8752
F-statistic	189.4	229.3	300.4	211.2	464.2
N	992	992	992	992	992

t-statistics given in parenthesis.