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**BINGE DRINKING, ALCOHOL PRICES,
AND ALCOHOL TAXES**

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Binge Drinking, Alcohol Prices, and Alcohol Taxes: A Systematic Review of Results for Youth, Young Adults, and Adults from Economic Studies, Natural Experiments, and Field Studies

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Background: Heavy episodic (“binge”) drinking of alcohol has serious public health implications, especially for youth and young adults. However, previous reviews have failed to address in a comprehensive manner the effects of alcohol prices and taxes on binge drinking by gender and age group. **Methods:** A systematic review is performed for possible effects of alcohol prices and taxes on binge drinking for three age groups. Outcomes examined include binge participation, intensity and frequency. Fifty-six relevant economic studies were recovered, with results distributed equally among three age groups. Also recovered were five natural experiments for tax reductions and six field studies, which increased the country coverage. Criteria for inclusion/exclusion and potential sources of bias are discussed, including adequacy of price and tax data. Price-binge relationships are judged using a 95% confidence interval ($p \leq 0.05$) for statistical significance. **Results:** More than half of economic studies report insignificant results for prices or taxes (30 null of 56 studies), with mixed results in 13 studies and significant results in only 13 studies. Null results are equally distributed across age groups, but some mixed results reflect different outcomes by gender. Prices or taxes are insignificant for 11 of 16 samples for men and 7 of 14 samples for women. Four of five natural experiments report null results for country-level tax cuts. Six field studies examine a variety of pricing methods and drink specials, but results are mixed. **Conclusions:** A large body of evidence now indicates that binge drinkers are not highly-responsive to increased prices or taxes, and may not respond at all. Non-responsiveness holds generally for younger and older drinkers and for male and female binge drinkers alike. Increased alcohol prices or taxes are unlikely to be effective as a means to reduce binge drinking, regardless of gender or age group.

Keywords: Binge Drinking, Alcohol Prices, Alcohol Taxes, Youth, Young Adults

INTRODUCTION

Understanding the determinants of excessive alcohol consumption, especially binge drinking, is important for informed alcohol policy and evaluation (Gilmore et al., 2013; Xu and Chaloupka, 2011). High-intensity drinkers who consume several drinks within a short time-period increase risks of serious health, safety and social problems for themselves and others (Anderson, 2008; USDOJ, 2004). For the United States, binge drinking accounts for more than half of an estimated 80,000 annual deaths and three-quarters of \$224 billion in economic costs resulting from excessive alcohol consumption (Bouchery et al., 2011; CDC, 2012). Binge drinking is strongly associated with alcohol-impaired driving, and alcohol-related fatalities are 20% of underage fatal accidents (Naimi et al., 2003; NHTSA, 2012). Binge drinking patterns vary importantly by age group and gender. In the US, prevalence (28.2%) and intensity (9.3 drinks per episode) are highest among young adults aged 18-24 years (CDC, 2012), and then decline with age. However, frequency (5.5 episodes per month) is highest among older adult bingers. Binge prevalence among men (23.2%) is more than twice the rate for women (11.4%), and intensity and frequency also are much higher for men. For persons under 18 years, binge drinking is a special concern since excessive use of alcohol and intoxication by youth are closely associated with similar problems in adult populations (Green and Ross, 2010; Nelson et al., 2005; USDHHS, 2012). Approximately 22% of US high school seniors engaged in binge drinking in 2011 (Johnston et al., 2012). Similar drinking patterns and costs are reported for other countries (Plant et al., 2010). For example, Anderson (2008) reports a binge prevalence of 28% for the European Union (EU), with frequency highest among persons aged 15-24 years. One in six (18%) EU youth report bingeing three or more times in the last month, and one in eight (13%) have been intoxicated more than 20 times in their life. Binge drinking is more common in

northern European countries, but high prevalence rates also are reported for some southern countries such as Spain (Ahlstrom and Osterberg, 2004/2005; Anderson, 2008; Soler-Vila et al., 2013). Overall, binge drinking in the United States is estimated to account for 90% of alcohol consumed by youth and young adults and 50% of alcohol consumed by adults (USDOJ, 2004). Country-level data for Europe indicate that high-intensity drinking is more strongly associated with alcohol-related problems compared to high per capita consumption (Bloomfield et al., 2003).

During the past several decades, economists have devoted considerable research to alcohol prices and taxes as determinates of drinking and drinking patterns, including binge drinking. Economic studies that incorporate prices or taxes fall into three general categories: first, population-level econometric studies for average per capita consumption based on aggregate data that include drinkers and non-drinkers alike, regardless of age, gender, or drinking patterns. A majority of studies contained in several recent meta-analyses fall into this category (Fogarty, 2009; Gallet, 2007; Nelson, 2013a; Wagenaar et al., 2009). Second, individual-level studies of alcohol use (participation, number of drinks per month), which do not include specific measures of heavy or binge drinking. Some price studies based on survey data, such as the Harvard College Alcohol Study, are informative for determinates of drinking generally but not necessarily for bingeing or other heavy drinking activity (An and Strum, 2011; Farrell et al., 2003; Picone et al., 2004; Williams, 2005). Third, individual-level studies of binge drinking that incorporate alcohol price or tax variables. These studies provide a stronger evidence base for effective alcohol policies that address abusive and high-intensity drinking. Most price-binge studies reviewed below use individual survey data for the United States, but coverage for other countries can be expanded by including available natural experiments and field studies.

Despite its importance, I found no previous reviews that address in a comprehensive manner the effects of alcohol prices and taxes on binge drinking by age group. Previous reviews either cover only a few early studies for youth (Chaloupka et al., 2002; Grossman et al., 1994; de Walque, 2014); omit prices and taxes as evidence (Ham and Hope, 2003; Kuntsche et al., 2004); or review relatively few economic studies for binge drinking. For example, a meta-analysis by Wagenaar and colleagues (2009) includes only 10 individual-level studies for heavy drinking, while Elder and colleagues (2010) cover 10 studies for excessive drinking, including two natural experiments. A systematic review by Patra and colleagues (2012) focuses on alcohol-related harms, but binge drinking studies are limited to only three economic studies and several natural experiments. Results by age or gender also are not reported in past reviews or apply mostly to early studies. In contrast, the present review examines 56 economic studies for binge drinking divided equally among three age groups. Results by gender are reported. Eleven natural experiments and field studies also are reviewed. As discussed below, discrepancies in prior reviews arise in part due to different methods required to search the economics literature on alcohol use. Further, several widely-cited studies have attempted to draw a general policy link between alcohol prices (or taxes) and excessive alcohol consumption, but evidence cited is mostly drawn from aggregate econometric studies (Anderson et al., 2009; Babor et al., 2010; Edwards et al., 1994; Nelson et al., 2013). This is incomplete and potentially misleading, since price and tax elasticity estimates for general populations may not apply equally to binge drinkers and other excessive drinkers (Ayyagari et al., 2013; Cook and Moore, 2000; Nelson, 2013b). Further, aggregate estimates tend to be biased away from zero (Manning et al., 1995; Nelson, 2013a). A comprehensive survey is required to address effects of prices and taxes on prevalence, intensity, and frequency of binge drinking for different age groups. To fill this gap, I conducted a

systematic review of individual-level studies designed to better understand the potential role of economic incentives for reduction of binge drinking.

MATERIALS AND METHODS

Literature search strategy

In order to conduct a systematic review, I followed internationally standardized protocol set forward in PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses; see Liberati et al., 2009). Literature searches were conducted by the author during October – November 2013 for English-language articles that empirically test the relationship between binge drinking and alcohol prices or taxes. Search terms used were: binge*, binge drink*, heavy drink*, intoxication, and price* or tax*, where * is the truncation indicator to include all forms of the root word (e.g., binge, binger, bingeing). No limitations were placed initially on comparison groups, outcomes, or study designs. However, a general strategy followed in many systematic reviews is to limit initial searches to title/abstract combinations of keywords, such as binge drink* AND price* OR tax*. This strategy does not perform well for research in economics as illustrated by the comparisons with earlier reviews or by meta-analyses conducted by Nelson (2013a) and Wagenaar et al. (2009); e.g., Nelson reports 135 articles that were not contained in Wagenaar et al. (2009). There are several reasons for these discrepancies: first, articles in economic journals usually contain brief abstracts (150-words or less) that disclose relatively little about specific details of statistical models or which emphasize only unique aspects of analyses. Structured abstracts are not used in economics journals. Second, because market price is a variable in virtually all microeconomic research, most titles and abstracts simply pass-over this variable as a non-unique aspect of research methods and results. Only early articles are likely to emphasize price or tax results for binge drinking. Third, many recent articles in economics are

not focused on binge drinking per se, but rather on adverse outcomes possibly affected by this and other drinking patterns, such as schooling, employment, earnings, violence, and drink-driving. Two-stage models estimated in this research area do not always report first-stage results for drinking or fail to disclose in the abstract that the paper contains results for alcohol prices or taxes. As a consequence, it was necessary to modify normal search strategies, so the initial search is for, say, binge drink* in the title/abstract and price* OR tax* in the full text. A cost of this approach is that many recovered articles fail to include empirical results, making it necessary to manually screen articles by examining text and tables for results that contain price/tax coefficients and dependent variables for binge drinking.

All search and data extraction activities were conducted by the author. The primary economic database was EconLit, which is part of EBSCOhost. For unpublished materials in economics, such as working papers, databases used were SSRN (Social Science Research Network), RePEc Ideas, and the Dissertation and Theses portion of ProQuest. I also conducted searches focused on economics using EBSCOhost, Google Scholar, JSTOR, ProQuest, and Wiley Online Library. Two public health databases were queried, MEDLINE (PubMed) and EMBASE. Except for natural experiments and field studies, relatively few articles were recovered using these databases since most relevant studies are published in economics journals. Prior reviews and an extensive on-line bibliography (Nelson, 2013a, 2013b) were used to trace references compiled in earlier work. Figure 1 illustrates search results obtained using EconLit. Table 1 illustrates difficulties encountered if initial searches were limited to keywords in title and abstract. There are 72 entries in Table 1, but several entries are duplicate studies, supporting studies, or report price/tax results for more than one age group. As demonstrated in the table, only half of the entries would be recovered by a conventional abstract-only search.

Inclusion and quality criteria

Initial retention was based on the following criteria: (1) study examines the relationship between alcohol prices/taxes and binge drinking or other measures of heavy drinking that can be interpreted as binge drinking (e.g., 35+ units of alcohol consumed per week); (2) study reports empirical results for a multivariate relationship, including price/tax regression coefficients and standard errors (t-statistics or p-values); (3) sufficient information is reported about measures of alcohol consumption, measures of alcohol prices or taxes, and average age(s) of survey respondents; and (4) study contains empirical results for binge participation, intensity, or frequency. In two cases, correspondence with authors obtained required information. Most studies use individual-level survey data, but two studies use survey data aggregated to the state level and two studies use aggregate national US data. Natural experiments are based on country-level tax reductions and individual-level surveys. Field studies are based on random and self-selected interviews, usually with college-aged respondents. Price measures in field studies are drink specials, such as happy hour discounts, free drinks, and fixed-fees for all-you-can-drink. Studies were excluded if the following quality criteria were met: (1) based on a laboratory experiment; (2) reports only simple correlations or regression estimates for prices/taxes are not reported; (3) uses interrupted time-series analysis; and (4) study is an undergraduate research paper. No studies were excluded for bias reasons, but in several cases there are potential biases that require comment. Most exclusions occur because studies simply do not include or do not report alcohol prices or taxes as a determinant of binge drinking. Quality of reported price/tax measures in economic studies is a special issue discussed below.

Data extraction

Many retained studies include measures and results for other drinking behaviors, but only binge drinking results are collected and examined in this review. Data extracted from each study include the sample population, subpopulations (age, gender, race), survey employed, average age or age range of respondents, measure(s) of binge drinking as outcomes, measure(s) of alcohol prices or taxes as interventions, statistical method(s) employed, control variables included in the model, and robustness tests. The basic result in each study is a coefficient estimate(s) for alcohol prices or taxes and its level of statistical significance for a given age group or gender. Exact quantitative estimates were not collected due to the diversity of models and results (e.g., participation and frequency elasticities are not comparable; price and tax elasticities are not comparable). The summary measure in this review is statistical significance for a price/tax coefficient at the 95% confidence level or better ($p\text{-value} \leq 0.05$). Results are analyzed according to estimated average age of respondents in each study or sample: youth (ages < 18 yrs.); young adults (ages 18-26 yrs.); and adults (ages > 26 yrs.). There are 56 economic results in the database, divided equally among three age groups. There are five natural experiments and six field studies. As noted in Table 1, several studies report results for more than one age group. Data are overwhelmingly for the United States, but studies also were retrieved for Australia (2 studies), Finland (1), Hong Kong (1), Iceland (1), Sweden (1), Switzerland (3), and the United Kingdom (3). Both published and unpublished materials are included: peer-reviewed articles, 51; book chapters, 6; dissertations, 6; and working papers, 3. There are 32 peer-reviewed articles published in economics journals and 19 published in public health journals, including 13 articles for natural experiments and field studies.

Potential sources of bias

In economic studies, two potential sources of bias are: (1) measurement errors in price/tax variables; and (2) omitted variable bias from unobserved state-level attributes that are correlated with state alcohol prices or taxes. Price data are not obtained from survey respondents and must be imputed based on respondents' place of residence (state or city). For the US, most researchers have used one of two approaches to measurement: ACCRA alcohol prices or state excise taxes. First, alcohol prices are included in ACCRA's Cost of Living Index (American Chamber of Commerce Researchers Association; see <http://www.coli.org/>), published quarterly for 300 medium and large US cities. Shelf prices are reported for one brand each of beer, wine, and blended whiskey. However, ACCRA data do not capture the full spectrum of alcohol prices (Gruenewald et al., 2006; Treno, 1993), and geographic details are limited. Young and Bielinska-Kwapisz (2003) examine measurement errors and endogeneity of ACCRA prices for demand for alcohol for a panel of 49 states in 1982-1997. Depending on model specification and econometric method, they find substantial variation of price elasticity estimates, which they conclude is evidence of measurement error. Ruhm and colleagues (2012) compare ACCRA prices to prices from Universal Product Code (UPC) scanner data on grocery store alcohol sales. They show that in most markets ACCRA prices are higher for beer and spirits and lower for wine. Using National Epidemiological Survey data, they demonstrate that ACCRA data fail to yield stable estimates of beer price elasticities.

Second, a widely adopted alternative is to use state alcohol excise taxes, especially beer taxes, as an empirical proxy for beverage prices.¹ A prime attraction is that taxes are policy

¹ Beer accounts for two-thirds of all alcohol consumed by binge drinkers (Naimi et al., 2007), and generally is the preferred beverage among males, young adults, and college students (Dawson, 1993; Kerr et al., 2004; Snortum et al., 1987).

variables. However, state taxes are a small percent of alcohol prices and tax rates have changed infrequently over time. Hence, cross-sectional variation in unobserved prices is likely dominated by non-tax factors and any temporal variation in real tax rates is largely due to general inflation (Dee, 1999b). Young and Bielinska-Kwapisz (2002) report that alcohol taxes are poor predictors of beverage prices, especially for beer. Ruhm and colleagues (2012) report that beer taxes are poor predictors of alcohol consumption compared to UPC scanner data. As a result of these measurement errors, many tax and price coefficients for binge drinking reported in economic studies are likely to be biased toward zero.

A related problem is identification of a causal link between state alcohol taxes (or prices) and drinking outcomes, including excessive drinking and alcohol-related harms. Dee (1999a, 1999c) argues that research results reporting a significant tax-binge relationship are plausibly explained by omitted cross-state attributes and unobserved heterogeneity. For example, state-level “drinking sentiment” will tend to be correlated with observed alcohol tax variables. As a result, cross-state variation in taxes may not provide a valid “natural experiment” or may overstate potential impacts of higher taxes as an alcohol policy. Dee argues that models that limit the number of state-specific variables lack a credible identification strategy, which imparts omitted variable bias to estimates of policy responsiveness for taxes. A statistical solution suggested by Dee (1999a, 1999c) is to include state fixed-effects in a panel data model (i.e., a binary variable for each state or local area), which captures relatively stable, but unobserved, cross-state differences potentially affecting drinking patterns and behaviors. In results reported below, I have highlighted studies that include state fixed-effects and other robustness tests. Many results are subject to interpretation due to identification issues, especially studies that rely exclusively

on cross-sectional data or which limit the number of control variables. Robustness tests also are reported less frequently for natural experiments and field studies.

RESULTS

Definition and sources of drinking measures

Results by age group are summarized in Table 2. More extensive results are available in Supplemental Tables (attached), including data sources, exact ages, statistical methods, robustness tests, and control variables. Most economic studies (44 of 56 table entries) are based on data sources that adopt a standard definition for binge drinking: 5 drinks or more on one occasion (5+ drinks) or 5+ drinks for men and 4+ for women (5/4+ drinks). Eight studies use 6+ drinks based on data in the National Longitudinal Survey of Youth. Four studies use varied definitions, including 50/35+ units in a week (2 studies); top 10% of alcohol use in sample; number of days intoxicated; and number of drunk events. Natural experiments generally use standard binge definitions, while field studies use measures of drunkenness including breath tests for intoxication. While definitions of binge drinking are fairly uniform, measures of behavior differ. For youth studies: 13 economic studies use binge participation (e.g., “any” binge drinking in past two weeks); four youth studies use binge frequency defined as two (three) or more binges in the past 14 (30) days or a continuous count of the number of binge episodes; and one study reports results for participation and frequency. For young adults, five studies use participation, six use frequency, two use binge intensity (number of drinks), and six report two measures (e.g., any binge drinking as a binary outcome and number of binges in past 30 days). For adults, eight studies use participation, four use frequency, three use intensity, and four use two measures. Natural experiments use binge participation, while field studies use intensity measures.

There are two primary US data sources for youth studies (15 of 18 table entries): Monitoring the Future (MTF) surveys and National Longitudinal Survey of Youth (NLSY). Two primary data sources for young adult studies (13 of 19 table entries) are: NLSY and Harvard College Alcohol Study (CAS). Data sources for adult studies are more varied, but there are two primary sources (10 of 19 table entries): Behavioral Risk Factor Surveillance System (BRFSS) and Health Interview Survey. All natural experiments and field studies are based on specially-designed surveys or interviews.

Price and tax measures

ACCRA prices or state excise taxes adjusted for inflation are used in most economic studies, but exact measures again vary. ACCRA beer prices at city- or state-levels are used in five studies and state excise taxes on beer are used in 21 studies. Weighted averages of ACCRA prices (beer, wine, whiskey) are used in 12 studies; weighted average or multiple taxes in five studies; and seven use national price indexes or other measures. Six Harvard CAS studies employ combinations of self-reported prices, fixed-fee prices, price discounts, and free drinks.

Binge drinking results for youth

There are 18 studies or samples for binge drinking by youth, but several are similar in design. Only three of 18 studies report protective results for price/tax interventions, indicating higher alcohol prices or taxes have a statistically-significant negative effect on youth bingeing (Bhatt, 2011; Grossman, 2005; Markowitz, 2001). Ten studies report insignificant or null results for prices or taxes, including NLSY results in Saffer and Dave (2006). Two studies reports mixed results for the same MTF sample (Chaloupka and Laixuthai, 1997; Laixuthai and Chaloupka, 1993), and three others report mixed results for racial or gender subsamples (Medina, 2011; Nair et al., 2001; Saffer and Dave, 2006). Price variables in eight supportive- and mixed-result studies

are varied: three use beer taxes; three use ACCRA prices; and two use aggregate BLS price indexes. Nine of ten null studies employ state-fixed effects or state-level variables as controls, including two studies with state “wetness” as a determinate of youth binge drinking (Nelson, 2008; Xuan et al., 2013).

Binge drinking results for young adults

There are 19 table entries for binge drinking by young adults, which can be divided into three groups: (1) five that do not report separate results by gender; (2) seven with results for males or both genders; and (3) seven based on the Harvard CAS. In the first group, one study reports mixed results that depend on data used (Keng, 1998; Keng and Huffman, 2007), and four studies report insignificant relationships between prices/taxes and binge participation or frequency. Also, Cook and Moore (1994, 2001) report insignificant results for pooled samples of men and women. In the second group, five of seven studies report insignificant results for males, and two of four report insignificant results for females. The United Kingdom study by Sutton and Godfrey (1995) reports a significant negative result for price and male bingeing, but they use a national price index that might pick-up other data trends. Several studies include a variety of state-level variables including legal drinking age (8 studies), drink-driving laws (2), alcohol availability (2), and state “wetness” (one study).

Six studies based on the Harvard CAS use self-reported information for alcohol prices, price discounts, and price promotions that reduce marginal costs to zero (fixed fees, free drinks). A seventh CAS study by Chaloupka and Wechsler (1996) uses ACCRA beer prices at the city level, with insignificant results. Significant negative effects for average price/fixed fees are reported in three studies (Powell et al., 2002; Wechsler et al., 2000; Weitzman et al., 2003); mixed results in one study (Williams et al., 2005); and insignificant results in two studies

(Wolaver, 2007; Wolaver et al., 2007a). Free drinks significantly *reduce* bingeing in two studies (Wechsler et al., 2000; Wolaver, 2007). Chaloupka and Wechsler (1996) and Wolaver (2007) report insignificant price effects for male and female binge drinkers, regardless of legal age. Control variables in CAS studies include demographics, fraternity/sorority (“Greek”) status, peers’ drinking, parents’ drinking, parents’ education, religiosity, alcohol availability, college-level bingeing, and drink-driving laws.

Binge drinking results for adults

There are 19 table entries for binge drinking by adults: five studies report that higher prices/taxes reduce binge participation or frequency by adults (Cook, 2007; Davalos et al., 2012; Kenkel, 1993; Ludbrook et al., 2012; Zhang, 2010), but 10 report insignificant or contradictory results. Four studies report mixed results: Kenkel (1996) finds a significant effect of price for better-informed drinkers only; Rhoads (2010) and Sloan and colleagues (1995) find a significant price effect for binge frequency, but not for participation; and Manning and colleagues (1995) report that price is significant for binge participation, but not for frequency. Significant price effects are reported for both men and women by Cook (2007) and Kenkel (1993). In some cases, significant tax elasticities appear to be too large to be credible (e.g., Zhang, 2010). Price measures in adult studies include beer taxes (3 studies); weighted average or multiple taxes (4); ACCRA beer prices (one study); weighted price or multiple prices (8); and price indexes (3). This is a diverse set of price measures, with no apparent impact on pattern of findings. All adult studies include income as a control variable, except McLellan (2011).

Binge drinking results from natural experiments and field studies

Table 2 summarizes results for five natural experiments and six field studies. The natural experiments examine tax reductions on beer and wine (Hong Kong), spirits (Sweden,

Switzerland), and all beverages (Finland). Tax cuts range from 100% in Hong Kong to about 30-50% in Nordic countries. A study for Finland by Helakorpi and colleagues (2010) finds mixed effects on binge drinking, while four other studies report null effects on binge drinking and heavy drinking more generally. In some cases, empirical results appear to be dominated by existing trends toward less binge drinking, which are not offset by tax cuts and reductions in alcohol prices.

There are four field studies for the United States, one for Australia, and one for the United Kingdom. Varied price measures are examined: free alcohol at events (2 studies); price discounting such as pitcher specials, drinking game discounts, and buying rounds (3); fixed-fee/cover charges for all-you-can drink (one study); and average price comparisons by drinking level (one study). A study by Clapp and colleagues (2003) reports null results for free alcohol, but Wagoner and colleagues (2012) find that free drinks increase binge drinking by both genders. Thombs and colleagues (2009) report that fixed-fees increase chances of intoxication among college students, but other price promotions are not significant. Stockwell and colleagues (1993) reports null results for price discounting among young adults in Australia, while Jamison and Myers (2008) and O'Mara et al. (2009) report mixed results for binge drinking and intoxication. Overall, this is a mixed set of results. Four United States studies use college student respondents, so results can be compared to seven studies using Harvard CAS data. Three CAS studies report that fixed fees increase binge participation (Powell et al., 2002; Wechsler et al., 2000; Weitzman et al., 2003), but three studies also report null results for fixed fees or free drinks (Williams et al., 2005; Wolaver, 2007; Wolaver et al., 2007a).

DISCUSSION

This paper presents a comprehensive review of empirical studies of the relationship between alcohol prices/taxes and binge drinking. The review includes numerous studies not examined in previous reviews and summarizes for the first time results by age group for youth, young adults, and adults. Gender-based results also are reported. A variety of survey-based data are employed in economic studies, while special surveys and interviews are used for natural experiments and field studies. Binge drinking outcomes include binge participation, intensity, and frequency. Alcohol price/tax measures include quarterly survey prices, state excise taxes, weighted averages of prices or taxes, self-reported prices, and various price discounts. For economic studies, 56 studies are examined with 30 null results, 13 mixed results, and 13 studies where a negative relationship with prices/taxes is more strongly supported. Findings also are null in more than half of results by age group: 10 null of 18 youth studies; 10 null of 19 young adult studies; and 10 null of 19 adult studies. Some mixed results reflect different outcomes by gender: prices or taxes are insignificant in 11 of 16 samples for men; and insignificant in 7 of 14 samples for women. Overall, evidence from economic studies does not support a protective effect for higher alcohol prices/taxes interventions on binge drinking outcomes, regardless of drinker's gender or age.

Similar results are obtained for natural experiments: four of five studies find no effect of substantial alcohol tax reductions. Field studies report more mixed results as various price measures have been examined, such as price discounting, fixed fees, and free drinks. For example, Stockwell and colleagues (1993, p. 1524) conclude that "respondents' reports as to whether the price of drinks was discounted . . . did not significantly predict either heavy drinking or harm." Free alcohol is unimportant in four studies (Clapp et al., 2003; Wagoner et al., 2012; Wechsler et al., 2000; Wolaver, 2007). On the other hand, one field and three CAS studies report

that fixed-fee offers are significant in some circumstances (Thombs et al., 2009; Powell et al., 2002; Wechsler et al., 2000; Weitzman et al., 2003). The “drink setting” might matter for binge drinking, but available evidence for price specials and similar methods is mixed and inconclusive. Additional research is required to establish which pricing methods are important for binge drinking, especially for young adults and college students.

Numerous alcohol policy articles and statements discuss price/tax increases as a “best buy” policy for control of excessive or abusive drinking and alcohol-related harms (Bloom, 2011; Nelson and Winters, 2012; WHO, 2011). For example, Babor and colleagues (2010, p. 242) state that “of all the policy options, alcohol taxes is rated as one of the strongest . . . [and] heavier drinkers appear to be as responsive as lighter drinkers, and these policies are effective for younger drinkers as well as adults.” A recent review by Livingston (2013, p. 374) argues that “many critics of alcohol taxation suggest that it fails to affect problematic drinkers [but] this is not supported by the literature, with studies showing that both young people and heavy drinkers respond to price changes.” A Global Strategy report of the World Health Organization (2010, p. 16) states that “. . . increasing the price of alcoholic beverages is one of the most effective interventions to reduce harmful use of alcohol.” These and similar statements tend to be based on limited literature reviews or econometric studies that focus on population-level demand, and not alcohol demands by individual binge drinkers and other heavy/excessive drinkers. Further, in many areas of health research, early results are often found to be overstated (Ionannidis, 2005). While the “law of demand” holds that price and consumption are inversely related, magnitude of the relationship by drinking pattern is an empirical issue. As demonstrated in this review, a large body of evidence now indicates that binge drinkers are not highly-responsive to increased prices

or taxes, and may not respond at all. Non-responsiveness holds generally for younger and older drinkers and for male and female binge drinkers alike.

Several shortcomings of papers that underlie this review should be kept in mind. First, most economic evidence pertains to the United States. However, natural experiments for other countries also fail to support alcohol tax increases. Second, many studies use data for alcohol prices and taxes that may contain too much measurement error to support robust relationships with binge drinking. Suggested improvements in price data include use of UPC scanner data or greater use of consumer expenditure data containing alcohol price information. However, Harvard CAS and field studies use a variety of self-reported pricing data, yet fail to conclusively support a price-binge relationship. Third, identification is an issue in many studies, especially those based on cross-sectional data or which ignore state fixed-effects. Fourth, more attention might be given to subsamples by age, gender, race, ethnicity, etc. Despite some limitations, results in this review are largely null or negative for a price-binge relationship. In conclusion, this review has assembled a substantial evidence-base, but it does not provide support for alcohol policies based on higher taxes or prices. Babor and colleagues (2010, p. 6) argue that alcohol policy science must be “evidence based,” and the evidence in this review indicates that non-fiscal approaches to alcohol policy and binge drinking are deserving of greater consideration and scrutiny.

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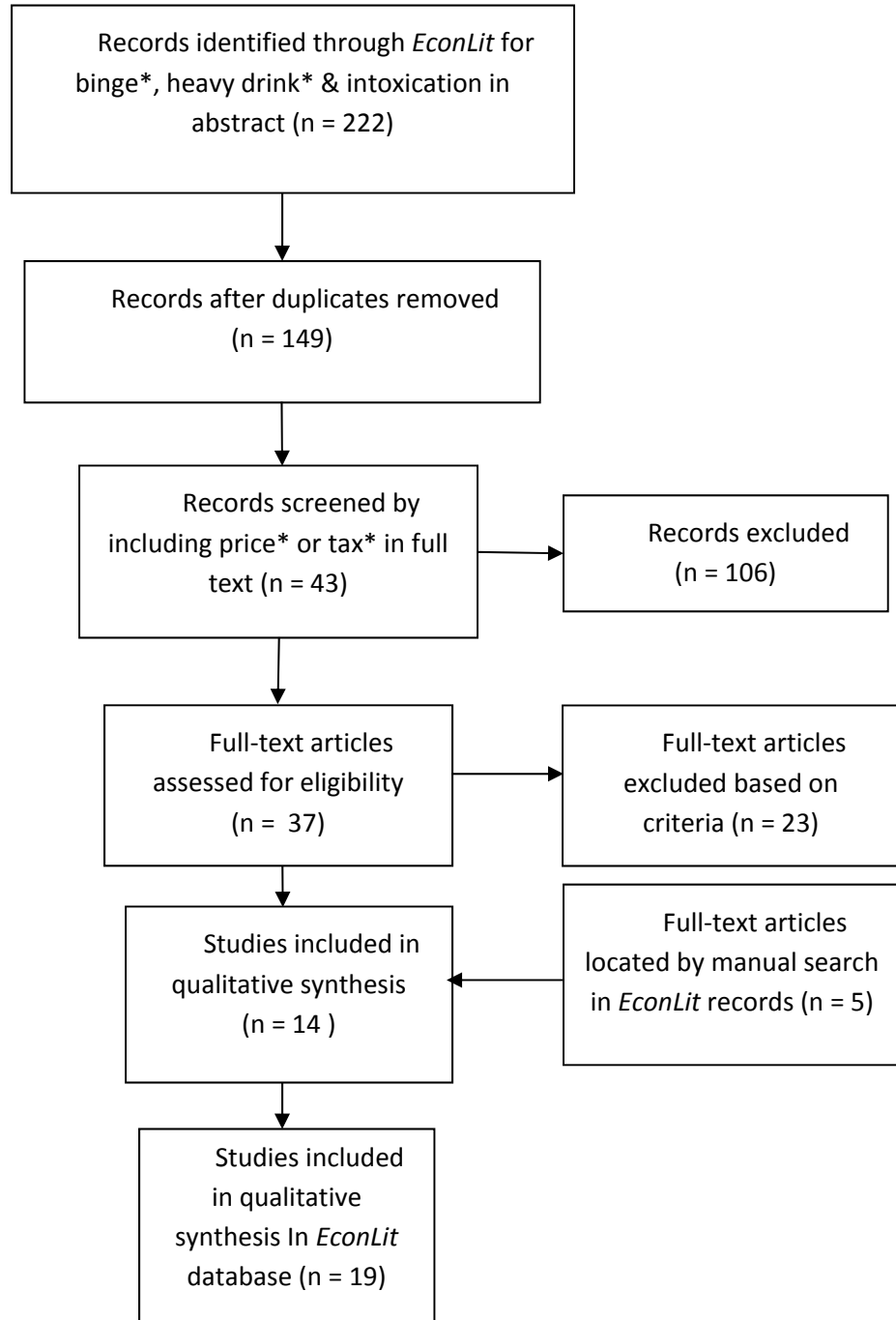
Figure 1. Flow Diagram for *EconLit* Search

Table 1. Frequency of keywords in title or abstract: recovered literature

Study (a = article, c = chapter, u = unpublished); country if not USA	Binge drink	Heavy drink	Intoxication	Price	Tax	No keywords	No abstract
Youth studies							
Bhatt (2011)* (a)	✓			✓			
Carpenter et al. (2007)* (a)		✓			✓		
Chaloupka & Laixuthai (1997) (a)						✓	✓
Chatterji (2001) (c)						✓	✓
Cowan (2011) (a)						✓	
Dee (1999b) (a)				✓	✓		
Dee (1999c) (a)					✓		
Dee & Evans (2003) (a)						✓	
Grossman (2005) (c)				✓	✓		
Laixuthai & Chaloupka (1993)* (a)		✓		✓	✓		
Markowitz (2001) (a)						✓	✓
Medina (2011)* (u)	✓			✓			
Nair (2001) (c)						✓	✓
Nelson (2008)* (a)	✓				✓		
Renna (2007) (a)	✓	✓					
Saffer & Dave (2006)* (a)	✓			✓			
Xuan et al. (2013)* (a)	✓				✓		
Young adult studies							
Bray (2000) (u)						✓	
Bray (2005) (a)		✓					
Chaloupka & Wechsler (1996)* (a)	✓			✓			
Cook & Moore (1994) (a)						✓	✓
Cook & Moore (2001) (c)						✓	✓
Cowell (2006) (a)	✓						
French & Maclean (2006) (a)						✓	
Gius (2003)* (a)	✓				✓		
Grossman et al. (1987) (c)						✓	✓
Keng (1998)* (u)	✓	✓		✓			
Keng & Huffman (2007)* (a)	✓			✓			
Kenkel (1993) (a)						✓	✓
Nelson (2008)* (a)	✓				✓		
Powell et al. (2002) (u)	✓						
Rhoads (2010)* (u)	✓			✓	✓		
Sutton & Godfrey (1995)* (a), UK		✓		✓			
Wechsler et al. (2000)* (a)	✓			✓			
Weitzman et al. (2003)* (a)	✓			✓			
Williams et al. (2005)* (a)		✓		✓			
Wolaver (2007) (a)	✓	✓					
Wolaver et al. (2007a) (u)	✓	✓					
Wolaver et al. (2007b) (u)	✓	✓					
Adult studies							
Asgeirsdottir (2012)* (u), Iceland		✓		✓			
Ayyagari et al. (2013)* (a)		✓		✓	✓		
Blumberg (1992) (u)						✓	✓
Byrnes et al. (2013) (a), Australia				✓	✓		
Cook (2007) (c)						✓	✓
Davalos et al. (2012) (a)	✓						
Dee (1999a) (u)					✓		
Gius (2002)* (a)	✓				✓		

Kenkel (1993) (a)						✓	✓
Kenkel (1996)* (a)		✓			✓		
Ludbrook et al. (2012)* (a), UK		✓			✓		
Manning et al. (1995)* (a)		✓		✓			
McLellan (2011)* (u)	✓	✓		✓	✓		
Nelson (2008)* (a)	✓				✓		
Popovici & French (2013) (a)	✓						
Rhoads (2010)* (u)	✓			✓	✓		
Sloan et al. (1995)* (a)		✓		✓			
Stout et al. (2000)* (a)		✓		✓			
Terza (2002) (a)					✓		
Zhang (2010)* (a)	✓				✓		
Experiments & field studies							
Chung (2013)* (a), Hong Kong	✓				✓		
Clapp et al. (2003) (a)		✓					
Gmel (2008) (a), Switzerland					✓		
Gustafsson (2010) (a), Sweden					✓		
Heeb (2003)* (a), Switzerland	✓			✓	✓		
Helakorpi (2010)* (a), Finland		✓		✓			
Jamison & Myers (2008)* (a), UK	✓			✓			
Kuo (2003) (a), Switzerland				✓	✓		
O'Mara et al. (2009)* (a)			✓	✓			
Stockwell et al. (1993) (a), Australia		✓	✓				
Thombs et al. (2008) (a)		✓					
Thombs et al. (2009) (a)		✓					
Wagoner et al. (2012) (a)		✓					
72 entries – Total checks	29	24	2	27	26	15	11

* = 34 studies more likely to be located with conventional keyword combinations for title and abstract.

Table 2. Summary of binge drinking and price/tax studies

Study	Binge drinking measures	Price/tax measures	Results ^a
Youth studies			
Bhatt (2011)	2+ episodes, 5+ drinks	ACCRA beer	Significant
Carpenter et al. (2007)	Any, 5+ drinks	beer tax	Not significant
Chaloupka & Laixuthai (1997)	Any, 5+ drinks	ACCRA beer	Signif. 1989, not signif. pooled
Chatterji (2001)	Any, 5+ drink; No. episodes	beer tax	Not significant
Cowan (2011)	No. episodes, 5+ drinks	beer tax	Not significant
Dee (1999b)	Any, 5+ drinks	beer tax	Not significant w/ fixed-effect
Dee (1999c)	Any, 5+ drinks	beer tax	Not significant w/ fixed-effect
Dee & Evans (2003)	Any, 5+ drinks	beer tax	Not significant w/ fixed effect
Grossman (2005)	Prevalence, 5+ drinks	BLS beer index	Significant
Laixuthai & Chaloupka (1993)	Any, 5+ drinks	beer tax	Signif. 1982, not signif. 1989
Markowitz (2001)	No. episodes, 5+ drinks	beer tax	Significant
Medina (2011)	Prevalence, 5+ drinks	BLS beer index	Signif., except males
Nair (2001)	Any, 5+ drinks	beer tax	Signif. males, not females
Nelson (2008)	Prevalence, 5+ drinks	beer tax	Not significant w/ fixed effect
Renna (2007)	2+ episodes, 6+ drinks	beer tax	Not significant
Saffer & Dave (2006)	Any, 5+ drinks	ACCRA ave.	MTF, signif. female, not male
Saffer & Dave (2006)	Any, 5+ drinks	ACCRA ave.	NLSY, not significant
Xuan et al. (2013)	Any, 5+ drinks	beer tax	Not signif. w/ adult binge incl.
Young adult studies			
Bray (2000, 2005)	3+ episodes, 6+ drinks	beer tax	Men only, not significant
Chaloupka & Wechsler (1996)	Any, 5/4+ drinks	ACCRA beer	Not significant, both genders
Cook & Moore (1994)	4+ episodes, 6+ drinks	beer tax	Signif. female; not signif. male
Cook & Moore (2001)	4+ episodes, 6+ drinks	beer tax	Not significant, both genders
Cowell (2006)	Any, 6+ drinks; 4+ episodes	beer tax	Men only, not significant
French & Maclean (2006)	No. days intoxicated	beer tax	Signif. male; not signif. female
Gius (2003)	Any, 6+ drinks	Wt. ave. tax	Not significant
Grossman et al. (1987)	No. drinks per day, incl. 6+	BLS prices	Not significant
Keng & Huffman (2007), Keng (1998)	4+ episodes, 6+ drinks	ACCRA ave., ACCRA beer	Significant ave. price; not significant for beer price
Kenkel (1993)	No. episodes, 5+ drinks	ACCRA ave.	Signif. female; not signif. male
Nelson (2008)	Prevalence, 5+ drinks	beer tax	Not significant
Powell et al. (2002)	Any, 5/4+ drink; 3+ episode	Ave price, fix fee	Signif. price; fix fee mixed
Rhoads (2010)	Any, 5+ drink; No. episodes	ACCRA ave.	Not significant
Sutton & Godfrey (1995)	Units per week, incl. 36+	Price index	Men only, significant
Wechsler et al. (2000)	Any, 5/4+ drinks	Ave. price, free	Signif. price; not signif. free
Weitzman et al. (2003)	Any, 5/4+ drinks	Ave price, fix fee	Significant both prices
Williams et al. (2005)	Any, 5/4+ drink; No. drunk	Ave price, fix fee	Signif price; not signif. fix fee
Wolaver (2007)	Any, 5/4+ drink; Any drunk	Ave, fix fee, free	Not significant, both genders
Wolaver et al. (2007a)	Any, 5/4+ drink; 2+ episode	Ave price, fix fee	Not signif. w/ binge rate incl.
Adult studies			
Asgeirsdottir et al. (2012)	Any, 5+ drinks	Price index	Not significant
Ayyagari et al. (2013)	No. episodes, 4+ drink	ACCRA ave.	Not significant
Byrnes et al. (2013)	No. drinks per day, incl. 5+	Price index	Not significant
Cook (2007)	Any, 5/4+ drinks	Wt. ave. tax	Significant, both genders
Davalos et al. (2012)	Any, 5/4+ drink; No episode	beer tax	Significant
Dee (1999a)	Any, 5+ drinks	Three taxes	Not significant, both genders
Gius (2002)	Any, 6+ drinks	Three taxes	Not significant
Kenkel (1993)	No. episodes, 5+ drinks	ACCRA ave.	Significant, both genders
Kenkel (1996)	No. episodes, 5+ drinks	ACCRA ave.	Not signif. except well-info

Ludbrook et al. (2012)	50/35+ units per week	Low price index	Significant
Manning et al. (1995)	Any, 5+ drink; No. episodes	ACCRA ave.	Mixed results; signif. part.
McLellan (2011)	Any, 5+ drinks	ACCRA beer	Not significant, w/ fixed effect
Nelson (2008)	Prevalence, 5+ drinks	beer tax	Not significant
Popovici & French (2013)	No. episodes, 5/4+ drinks	ACCRA prices	Not significant, both genders
Rhoads (2010)	Any, 5+ drink; No. episodes	ACCRA ave.	Mixed results; signif. freq.
Sloan et al. (1995)	Any, 5+ drink; No. episodes	ACCRA ave.	Mixed results; signif. freq.
Stout et al. (2000)	Any, 5+ drinks	ACCRA ave.	Not significant
Terza (2002)	Top 10% of use	beer tax	Not significant
Zhang (2010)	Any, 5+ drinks	Three taxes	Women, significant
Experiments & field studies			
Chung et al. (2013)	Any, 5/4+ drinks	100% tax cut	Not significant
Clapp et al. (2003)	Any, 5+ drinks	Free drinks	Not significant
Gmel et al. (2008)	40/20g+ per day	30-50% tax cut	Not significant, long-run
Gustafsson (2010)	No. units, top 10% of use	45% tax cut	Not significant
Heeb et al. (2003)	Any, 6/4+ drinks	9-50% tax cut	Not significant
Helakorpi et al. (2010)	Any, 6+ drinks	33% tax cut	Mixed results, both genders
Jamison & Myers (2008)	Any, 5/4+ drinks	Price specials	Not significant
O'Mara et al. (2009)	Breath test; no. grams	Price per gram	Significant
Stockwell et al. (1993)	Any, 6/4+ drinks	Price specials	Not significant
Thombs et al. (2008, 2009)	Breath test	Price specials	Fixed fee signif., others not
Wagoner et al. (2012)	Any, 5/4+ drinks	Free drinks	Significant

^a Price-binge relationships are judged using a 95% confidence interval ($p \leq 0.05$) for statistical significant. More detailed results are available in the attached Supplemental Tables (below).

SUPPLEMENTAL TABLES (4)

**Binge Drinking, Alcohol Prices, and Alcohol Taxes: A Systematic
Review of Results for Youth, Young Adults, and Adults from
Economic Studies, Natural Experiments, and Field Studies**

Supplemental Table 1. Youth alcohol studies (age < 18 yrs.): binge drinking and prices/taxes

Study	Data, Ave. age (est.)	Alcohol measure	Price/tax measure	Methods	Controls	Results
Bhatt (2011)	NLSY, 1997-2003. Age = 16 yrs.	Two or more binge drinking episodes in past 30 days (5+ drinks).	ACCRA beer price at state level, inflation-adjusted.	Probit. Two-stage IV model for drinking & parental transfers.	Demographics, family income, education, year & region fixed-effects , etc.	Price is significant in four cases. Pseudo R-sqs. are small.
Carpenter et al. (2007)	MTF, 1976-2003. Age = 17.5 yrs.	Any binge drinking in past 2 weeks (5+ drinks).	State & federal beer taxes, inflation-adjusted.	Linear probability & logit models. Robustness tests.	Demographics, legal age, zero tolerance laws, year & state fixed-effects.	Beer tax is insignificant in six cases.
Chaloupka & Laixuthai (1997); Laixuthai & Chaloupka (1993)	MTF, 1982 & 1989. Age = 17.5 yrs.	Any binge drinking in past 2 weeks (5+ drinks).	State beer tax (1993). ACCRA beer price, adjusted for inflation & city-specific cost-of-living (COL) in 1997 study.	Probit models. Separate results for 1982 & 1989, & pooled sample.	Demographics, income, legal age, border-state age, religion, work status & marijuana laws in 1997 study.	In 1993 study, tax is significant in 1982, but not 1989. In 1997 study, price is significant in 1989, but not in pooled sample.
Chatterji (2001)	NLSY, 1997. Age = 15 yrs.	Any binge drinking in past 30 days (5+ drinks). No. of binge episodes in past 30 days.	State beer tax.	Logistic model for participation. OLS model for no. of binge episodes.	Demographics, income, drug use, religion, parents' education, etc.	Participation, beer tax is insignificant. Frequency, tax is insignificant.
Cowan (2011) & private communication with author on 10/29/2013.	NLSY, 1997-2006. Age = 17 yrs.	Number of binge episodes in past 30 days (5+ drinks).	State beer tax, inflation-adjusted.	OLS & IV models for risky behaviors. Robustness tests.	Demographics, parents' education, family income, AFQT score, year & region fixed-effects.	Tax coefficient is small & insignificant.
Dee (1999b)	MTF, 1977-92. Age = 17.5 yrs. Pseudo-panel data.	Any binge drinking in past 2 weeks (5+ drinks). Prop. in a cell that binge drink.	State & federal beer taxes, inflation-adjusted.	WLS regression model (wts. are respondents per cell). Tests for robustness , incl. gender & race effects.	Demographics, legal age, cigarette tax, time trends, year & state fixed-effects , etc.	Beer tax is significant without & insignificant or positive with fixed-effects.
Dee (1999c)	MTF, 1977-92. Age = 17.5 yrs. Pseudo-panel data. Sample also for 19 states with beer tax changes.	Any binge drinking in past 2 weeks (5+ drinks). Prop. in a cell that binge drink.	State & federal beer taxes, inflation-adjusted.	WLS regression model (wts are respondents per cell). Tests for robustness , incl. tax change model.	Demographics, legal age, year & state fixed-effects. Other samples yield similar results.	Beer tax is significant without & insignificant with state fixed-effects.
Dee & Evans (2003)	MTF, 1977-92. Age = 17.5 yrs. Pseudo-panel data.	Any binge drinking in past 2 weeks (5+ drinks). Prop. in a cell that binge drink.	State & federal beer taxes, inflation-adjusted.	WLS regression model (wts. are respondents per cell). Two-stage IV model for drinking & education attainment.	Demographics, legal age, year & state fixed-effects. Tests for robustness.	Tax is negative & significant without fixed-effects & insignificant with state fixed-effects.

Grossman (2005)	MTF, 1976-2003. Annual aggregate national data. Age = 17.5 yrs.	Prevalence of binge drinkers in past 2 weeks (5+ drinks).	Bureau of Labor Statistics (BLS) beer price index, inflation-adjusted.	OLS time-series regression. Data not tested for stationarity.	Legal age for beer (population wts.) & time trends.	Beer price is negative & significant in two cases. Large elasticities.
Markowitz (2001)	National Youth Risk Behavior Survey, 1991, 1993 & 1995. Age = 16 yrs.	Number of binge episodes in past 30 days (5+ drinks).	State beer tax, inflation-adjusted.	Linear probability model. Two-stage model for drinking & violence.	Demographics, income, work status, religion, year effects, etc. Checks for valid instruments.	Beer tax is negative & significant in first-stage results.
Medina (2011)	MTF, 1976-2008. Age = 17.5 yrs. Wt. national averages, with subsamples by gender & race.	Prevalence of binge drinkers in past 2 weeks (5+ drinks) in each sample & year.	BLS beer price index, inflation-adjusted.	OLS time-series, linear & double-log regressions. Data not tested for stationarity.	Income, parents' education, mother's employment, legal age, risk perceptions, & time trends.	Price of alcohol is generally negative & significant, except for males & non-Whites.
Nair et al. (2001)	MTF, 1982 & 1989. Age = 18 yrs. Sub-samples by gender & race.	Any binge drinking in past 2 weeks (5+ drinks).	State & federal beer taxes, adjusted for inflation & city COL.	Probit model by demographic subgroups.	Demographics, income, legal age, religion, mother's work status, marital status, border-state age, residence, year effects, etc.	Beer tax is significant for males overall, Whites overall, & White males. Insignificant for females overall, Blacks overall, & Black males & females.
Nelson (2008)	National Survey on Drug Use & Health, 1993-2003, at state level. Age = 15 yrs.; range 12-17 yrs.	Prevalence of binge drinking by state (5+ drinks). State-level adult binge rate as control.	State beer tax, inflation-adjusted. State laws on alcohol availability & drink-driving.	Linear probability model. Models fit with & without state fixed-effects .	Demographics, income, poverty, education, outlet density, etc., availability, adult binge rate, yr fixed-effects .	Tax is negative & significant without fixed effects, but insignificant with state fixed-effects.
Renna (2007)	NLSY, 1982-84 for high school seniors. Age = 17.5 yrs.	Two or more binge drinking episodes in past 30 days (6+ drinks).	State beer tax (inflation-adjustment not reported).	Probit model. Two-stage IV model for drinking & on-time graduation.	Demographics, income, legal age, parents' drinking, AFQT score, state fixed-effects .	Beer tax is insignificant.
Saffer & Dave (2006); two samples	Two samples: MTF, 1996 & 1998. Age = 15 yrs. MTF subsamples by gender & race. NLSY, 1997. Age = 15 yrs.	Any binge drinking in past 30 days (5+ drinks).	ACCRA wt ave. price per ounce of ethanol, adjusted for inflation & city COL.	Probit model for each sample. Robustness tests for NLSY sample.	Demographics, income, region, education, religion, year & state fixed-effects , etc.	MTF, price is significant for full sample, Whites only & females only. Insignificant for males & Blacks. NLSY, price is insignificant in four cases.
Xuan et al. (2013)	National Youth Risk Behavior Survey, 1999-2009. Age = 16 yrs.	Any binge drinking (5+ drinks). State-level adult binge rate as control.	State beer tax & state sales tax, when applied (no inflation-adjustment reported).	Logistic model, with robust std. errors. Tax rate interactions with adult binge rate.	Demographics, grade level, etc., state-level var. for income, etc. outlet density & adult bingeing.	Beer tax is significant when adult binge rate excluded, but insignificant if it is included.

ACCRA = American Chamber of Commerce; MTF = Monitoring the Future; NLSY = National Longitudinal Survey of Youth.

Supplemental Table 2. Young adult alcohol studies (ages 18-26 yrs.): binge drinking and prices/taxes

Study	Data, Ave. age (est.)	Alcohol measure	Price/tax measure	Methods	Controls	Results
Bray (2000, 2005)	NLSY, 1982-89. Males only, age = 22 yrs.	Binge drinking on 3 or more occasions in past 30 days (6+ drinks). Model with cumulative alcohol use as a control.	State beer tax, inflation-adjusted.	Logit model & discrete factor method (DFM) to control for endogeneity & sample selection. Two-stage model for drink & wages.	Demographics, religion, legal age, work status, education, cigarette tax, etc. Tests for robustness.	Men, tax is negative & significant in logit model. Tax is insignificant in DFM model.
Chaloupka & Wechsler (1996)	Harvard College Alcohol Study, 1993. Age = 21 yrs. Subsamples for legal age & underage students.	Any binge drinking in past 2 weeks (5/4+ drinks).	ACCRA beer price for nearest city, adjusted for city cost-of living (COL).	Probit model. Results for full & limited models. Results by age & gender subsamples.	Demographics, Greek status, marital status, religion, region, availability, college-type, drink-driving law index, etc.	Men, price is insignificant for underage & legal age people. Women, price is insignificant for underage & legal age people.
Cook & Moore (1994)	NLSY, 1984. Samples for ages 19-22 yrs. & 25-26 yrs. Age = 20.5 yrs. & 25.5 yrs.	Binge drinking on at least 4 occasions in past 30 days (6+ drinks).	State beer tax.	Logistic models for young & older samples. Samples for men, women, 21-22 yrs., & combined.	Demographics, parents' education, religion, family size, legal age, etc.	Men, tax is insignificant in 5 of 6 regressions. Women, tax is significant for older women. Combined, tax is insignificant in 4 of 5 cases.
Cook & Moore (2001)	NLSY, 1982-85 & 1988-89. Age = 18.5 yrs.	Binge drinking on at least 4 occasions in past 30 days (6+ drinks). State "wetness" variable for per capita ethanol consumption.	State beer tax, inflation-adjusted.	Probit models, short- & long-form results, & gender-specific results. Reports policy model results without & with state fixed-effects .	Demographics, income, parents' education, legal age, religion, marital status, region, work status, parents' drinking, family size, residence, etc.	Men, tax is insignificant. Women, tax is insignificant. Combined, tax is insignificant. In policy model, tax insignificant when "wetness" variable is added
Cowell (2006)	NLSY, 1982-94. Males only, age = 23 yrs.	Any binge drinking in past 30 days (6+ drinks) & frequent bingeing conditional on binge drink (4+ occasions).	State beer tax, inflation-adjusted.	Probit model. Two-stage DFM model for education & health behavior, with & without unobserved heterogeneity controls.	Demographics, parents' education, religion, family structure, region, cigarette price, etc. Robustness tests.	Men, any binge drinking, tax insignificant in both regressions. Frequent binge drinking, tax is insignificant in both regressions.
French & Maclean (2006)	National Epidemiological Survey on Alcohol, 2001-02. Age = 19 yrs.	No. of days respondent felt intoxicated in past year (mean = 10.17 days).	State beer tax.	OLS model, with separate results for men & women. Two-stage IV model for drinking & delinquency.	Demographics, income, education, work status, family size, parents' drinking, etc.	Men, tax is negative & significant. Women, tax is insignificant.

Gius (2003)	NLSY, 1982 & 1994. Control states excluded. Age = 24 yrs.	Any binge drinking in past 30 days (6+ drinks).	State wt. ave. tax per gal. (share wts.), divided by state alcohol price. Bureau of Labor Statistics (BLS) real price of alcohol by region.	Logit model, with both state tax rate & regional price included.	Demographics, income, education, region, family drinking, legal age, etc.	Tax rate & price are insignificant.
Grossman et al. (1987)	National Health & Nutrition Examination Survey, 1971-74. Age = 18.5 yrs.	Category variable, no. of drinks on a typical drinking day (1-2, 3-5, 6+ drinks).	BLS prices for beer, wine & spirits for 1971. Extrapolated for 1972-74 & not deflated.	Multinomial logit model. Separate results for each drink category & beverage.	Demographics, income, legal age, & border-state age.	Prices of beer & wine are insignificant for all 3 categories. Price of liquor is insignificant for 6+ drinks.
Keng & Huffman (2007); Keng (1998)	NLSY, 1979-94. Age = 25 yrs.	Binge frequency none (0); moderate (1-3 times); & heavy (4+ times) in past 30 days (6+ drinks).	ACCRA wt. ave. real price per gal. ethanol. ACCRA real price of beer.	Ordered probit model. Two-stage IV model for drinking & annual labor earnings.	Demographics, work earnings, health status, marital status, religion, legal age, etc. Year & state fixed-effects.	Price of alcohol is significant. Short- & long-run elasticities are substantial. In Keng (1998), beer price is insignificant.
Kenkel (1993)	Health Promotion & Disease Prevention suppl. to Health Interview Survey, 1985. Sample for ages 18-21 yrs. Ave. age = 19.5 yrs.	No. of binge days in past year (5+ drinks).	ACCRA wt. ave. price for three beverages (budget share wts.), deflated by city COL.	Tobit model. Two-stage model for drinking & drink driving. Results for males & females.	Demographics, income, legal age, education, marital status, health knowledge, drink-driving laws, border-state age, state alcohol laws, etc	Men, price is insignificant. Women, price is significant & elasticity is substantial.
Nelson (2008)	National Survey on Drug Use & Health, 1993-2003, at state level. Ave. age = 21.5 yrs.; range 18-25 yrs.	Prevalence of binge drinking by state (5+ drinks).	State beer tax, inflation-adjusted. State laws on alcohol availability & drink-driving.	Linear probability model. Models fit with & without state fixed-effects.	Demographics, income, poverty, education, outlet density, region, availability, etc., year & state fixed-effects,	Tax is insignificant or incorrectly signed, with or without state fixed-effects.
Powell et al. (2002)	Harvard College Alcohol Study, 1997 & 1999. Undergrads, age = 21 yrs.	Any binge drinking in past 2 weeks (5/4+ drinks). Binge frequency is 3 or more episodes in past 2 weeks.	Two prices at college level: average real price, self-reported; & proportion who pay fixed fee for all they can drink.	Probit models. Two-stage model for drinking & violence. Tests for endogeneity.	Demographics, residence, parents' education parents drinking, school year, campus type, availability, happy hour restrictions, etc.	Ave. price is significant for participation & frequency, but small in magnitude. Fixed fee is positive for any participation & insignificant for frequency.

Rhoads (2010)	BRFSS, 1991-2004. Samples for 18-20 yrs. & 21-24 yrs. Ages = 19 yrs. & 22 yrs.	Any binge drinking in past 30 days (5+ drinks). No. of binge episodes in past 30 days (count data).	ACCRA wt. ave. real price per ounce of ethanol.	Probit model for any bingeing. OLS model for frequency, but ignores count data feature	Demographics, income, marital status, work status, region, education, cigarette tax, year fixed-effects , etc.	Any bingeing & binge frequency, alcohol price is insignificant for both age groups.
Sutton & Godfrey (1995)	UK, General Household Survey (GHS), 1978-90. Males, age = 21 yrs.; age range is 18-24 yrs.	GHS drinking categories, three highest for units/week are: 22-35, 36-50, & 51+ drinks. The "at-risk" group is > 21 units per week.	National price index: alcohol expenditure at current prices divided by expenditure at 1985 prices, deflated by all items price index.	Grouped data regression for seven categories of drinkers. Robustness tests for log model, OLS, etc. Interactions between price & income.	Demographics, income, wealth, education, marital status, work status, peers' drinking, health status, smoking status, etc.	Men, price is significantly negative & interactions are significant, but difficult to interpret. A 5% price increase has a large impact on at-risk group.
Wechsler et al. (2000)	Harvard College Alcohol Study, 1997. Underage students < 21 yrs.; age = 20 yrs.	Any binge drinking in past 2 weeks (5/4+ drinks).	Price per drink, self-reported in four categories: > \$3, \$1-\$3, < \$1 or set fee; & usually free.	Logistic model, Generalized Estimating Equation (GEE) for robust std. errors. Partial models. Full model not reported.	Demographics, region, & response rate.	Lower prices or set fee are significant for probability of binge drinking. Free drinks are significantly likely to reduce bingeing.
Weitzman et al. (2003)	Harvard College Alcohol Study, 1999. College freshman, aged ≤ 19 yrs. Age = 18.5 yrs.	Any binge drinking in past 2 weeks (5/4+ drinks).	Price variable: "usually pay \$1 or less per drink or set fee."	Logistic regression, with GEE for std. errors. Only final model reported	Demographics, Greek status, peers' drinking, availability, wet setting, college type, etc.	Final regression, low price or set fee significantly associated with binge drinking.
Williams et al. (2005)	Harvard College Alcohol Study, 1997 & 1999. Undergrads, < 25 yrs.; age = 21 yrs.	Heavy drinker: > 5/4+ drinks per occasion. Index for no. of drunk events in past 30 days: none; less than 4; & more than 4 events.	Two prices at college level: ave. real price (excl. zeros), self-reported; & prop. paying fixed fee for all they can drink.	Ordered logit models Robustness tests for campus drinking bans & state fixed-effects.	Demographics, religion, parents drinking, college type, cigarette price, education, availability, state fixed-effects , etc.	Higher price reduces odds of heavy drinking & drunk events. Fixed fee is insignificant with state fixed-effects included.
Wolaver (2007)	Harvard College Alcohol Study, 1997. Age = 21 yrs.	Any binge drinking in past 2 weeks (5/4+ drinks). Any drunk events in past 30 days.	Three price measures: ave. college price (excl. zeros), self-reported; prop. of students who pay fixed fee; & prop. who drink free.	Probit model. Two-stage IV model for drinking & college grade pt. ave. Results by gender.	Demographics, religion, Greek status, family income, parents' drinking, access, cigarette use, college type, etc.	Men, price variables are insignificant for bingeing & drunkenness; free drinks reduce bingeing. Women, all price variables are insignificant.

Wolaver et al. (2007a); see also Wolaver et al. (2007b)	Harvard College Alcohol Study, 1997 & 1999. Age = 21 yrs.	Any binge drinking in past 2 weeks (5/4+ drinks). Frequent bingeing is 2+ times or more in past 2 weeks.	Two real prices at college level: ave. real price (excl. zeros), self-reported; & prop. paying fixed fee for all they can drink.	Probit model. Two-stage IV model for bingeing & college-level (peer) binge rate.	Demographics, religion, marital status, Greek status, region, residence, income, parents' drinking, availability, college type, state & local alcohol policies, etc.	Probit, both prices are insignificant for binge & frequent binge, when college-binge rate is included. First-stage results, price is significant & fixed fee is insignificant.
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BRFSS = Behavioral Risk Factor Surveillance System.

Supplemental Table 3. Adult alcohol studies (ages > 26 yrs.): binge drinking and prices/taxes

Study	Data, Ave. age (est.)	Alcohol measure	Price/tax measure	Methods	Controls	Results
Asgeirsdottir et al. (2012)	Iceland Health & Lifestyle Survey, 2007 & 2009. Age = 45 yrs.; age range 18-79 yrs.	Binge drinking at least once a month in past year (5+ drinks).	Price index from Statistics Iceland, inflation-adjusted.	Probit model for change in binge status, net of time-varying covariates. Also SUR & linear prob. models.	Demographics, income, hrs. worked, health status, marital status, residence, education, etc.	Binge elasticity is negative, but not significant.
Ayyagari et al. (2013)	Health & Retirement Study, 1996-2004. Age = 65 yrs.; age range 51 – 81+ yrs.	Ave. number of drinks per day & number of binge days in past 3 months (4+ drinks).	ACCRA ave. price at state level, adjusted for ethanol content per drink, state cost-of-living (COL) & inflation.	Two- & three-component finite mixture model (FMM), with Poisson-distributed subpopulations. Two latent groups recovered.	Demographics, income, risk aversion, health, education, work status, marital status, etc. Robustness tests include state laws on drink driving, beverage prices, etc.	Moderate drinkers are price responsive, & more likely to be older, non-white, female, married & less educated. Heavier drinkers are insensitive to price & more likely to binge.
Byrnes et al. (2013) & Web appendix	Australia, National Drug Strategy Household Survey, 2001, 2004 & 2007. Age = 45 yrs.	Number of days alcohol was consumed at four intensities for std. drinks per occasion (0, 1-4, 5-9, 10+ drinks).	Price index for alcohol products from national sales data, adjusted for state consumer price index (CPI) & inflation.	Pooled 3SLS for each of four intensities. Coefficients constrained to sum to zero.	Demographics, income, work status, marital status, year education, residence, etc.	Frequency of consumption is responsive to price at lowest intensities, but insignificant at two highest (5-9, 10+ drinks).
Cook (2007, pp. 73-75)	NESARC, 2001-2002. Age range = 18 yrs. & older. Control states excluded.	Any binge drinking in past year (5/4+ drinks). State wetness measured by ave. per capita ethanol sales.	State-level tax index for 2000, based on tax rate & ethanol content for each beverage.	Logit model for men & women separately. Reports percent change in odds of bingeing. Subsamples estimated, but not reported.	Demographics, income, work status, marital status, health status, education, height, weight, & state “wetness.”	Tax coefficients are negative & significant for both men & women. Effects are substantial for both genders.
Davalos et al. (2012)	NESARC, 2001-02 & 2004-05. Age = 46 & 49 yrs.	Any binge drinking in past year. No. of binge days in past year (5/4+ drinks). Dependent variables also for drink-driving & alcohol dependence.	State beer tax per 12-oz. drink, inflation-adjusted.	Conditional logit model for participation & conditional negative binomial model for frequency, with controls for state & individual fixed-effects.	Demographics, income, marital status, health status, state unemployment, residence, state wetness (ethanol per capita), etc. Robustness tests for state unemployment & month of interview.	Tax is negative & significant for any bingeing in one of two regressions. Tax is negative & significant for binge frequency. Beer tax is insignificant for two other drink measures.

Dee (1999a)	BRFSS, 1984-95. Age = 45.5 yrs.; range 18 to 56+ yrs. Pseudo-panel data. Sub-samples by age, gender, race & work status.	Any binge drinking in past 30 days (5+ drinks).	Real state & fed. beer tax; state & fed. liquor tax for license states; & wt. ave. tax per gal. ethanol for license states.	Linear probability model for pseudo-panel data, with & without state fixed-effects for full sample.	Demographics, family income, parents' education, marital status, state income, state trends & year & state-fixed effects.	All taxes are insignificant or incorrectly positive in 8 of 9 cases for full sample. Taxes are insignificant for men & women samples.
Gius (2002)	National Longitudinal Survey of Youth, 1994. Age = 31 yrs.; range 29-33 yrs.	Any binge drinking in past 30 days (6+ drinks). Total & drinkers only samples.	State-level alcohol taxes for each beverage in dollars per gal. Excludes control states.	Probit model, with all three taxes included.	Demographics, income, marital status, debt load, education, work status, etc.	All three taxes are insignificant in four regressions for binge drinking.
Kenkel (1993)	Health Promotion & Disease Prevention suppl. to 1985 Health Interview Survey. Age = 42.5 yrs. for men & 44 yrs. for women.	No. of binge days in past year (5+ drinks).	ACCRA wt. ave. price for three beverages (budget share wts.), deflated by city COL.	Tobit model. Two-stage model for drinking & drink driving. Results for males & females.	Demographics, income, education, health status & knowledge, marital status, state drink-driving & alcohol laws, etc	Men, price is negative & significant. Women, price is negative & significant. Substantial elasticities.
Kenkel (1996)	Health Promotion & Disease Prevention suppl. to 1985 Health Interview Survey. Age = 43 yrs. for men & 46 yrs. for women.	No. of binge days in past year (5+ drinks).	ACCRA wt. ave. price for three beverages (budget share wts.), deflated by city COL.	Tobit model, with separate results for males & females. Robustness test with two-stage model for non-zero demands.	Demographics, income, marital status, border price, state drink driving & alcohol laws, etc. Health knowledge about heavy drinking, interacted with price.	Direct price effect is insignificant for men & women, but interaction with knowledge is significant. Price effects are significant for drinkers with average or better knowledge, but insignificant for poor-informed.
Ludbrook et al. (2012)	United Kingdom, Expenditure & Food Survey, 2006-08. Age = 51 yrs.	Harmful drinking is 50+ units per wk. for men & 35+ units per wk. for women per UK Guidelines.	Estimates of no. units of alcohol purchased & no. purchased at under £0.45 (\$0.89USD), off-trade.	Two-part model: probit model for off-trade buys; & tobit model for number of cheap units purchased, off-trade	Age, income, no. of children, & survey year. Pseudo R-sq. is very small.	Relative to moderate drinkers, harmful drinkers purchased significantly more units of cheap alcohol.
Manning et al. (1995); see also Blumberg (1992)	Alcohol & Health Practices suppl. to 1983 Health Interview Survey. Age = 39.5 yrs.	Any binge drinking in past year. Number of binge days in past year (5+ drinks).	ACCRA wt. ave. real price per unit of ethanol, adjusted for state sales tax & ave. of the Bureau of Labor Statistics (BLS) & ACCRA COL indexes.	Two-part model: logit model for being a binge drinker & conditional OLS for frequency of binge drinking. Some results for quantile model.	Demographics, income, family size, education, residence, region, etc. Price response in quantile model diminishes as drink level increases.	Price elasticity for participation is significant, but conditional & total elasticities are insignificant. Price response for no. of ounces is insignificant.

McLellan (2011); see also McLellan et al. (2012)	BRFSS, 2001-05. Age = 45 yrs. Sub-samples by gender, but beer price results not reported.	Any binge drinking in past 30 days (5+ drinks).	ACCRA beer price, unwt. state average, inflation-adjusted.	Logit model for total sample & linear prob. model for gender results. Robustness tests for sample wts.	Demographics, poverty status, partner status, work status, education, cigarette price, etc., regional & state fixed-effects.	Price is significantly less than one with regional fixed-effects, but insignificant with state fixed-effects included.
Nelson (2008)	National Survey on Drug Use & Health, 1993-2003, at state level. Age = 45 yrs.	Prevalence of binge drinking by state (5+ drinks).	State beer tax, inflation-adjusted. State laws on alcohol availability & drink-driving.	Linear probability model. Models fit with & without state fixed-effects.	Demographics, income, poverty, education, outlet density, region, availability, etc.,	Tax is insignificant in models with or without state fixed-effects.
Popovici & French (2013); & private communication with authors on 12/04/2013	NESARC, 2001-02 & 2004-05. Age = 44 yrs.; age range = 21 - 65 yrs. Excludes pregnant women & homemakers.	Number of binge drinking days in past year (5/4+ drinks). Also diagnosis for alcohol dependence.	ACCRA prices for beer, wine & spirits (each), adjusted for state COL index.	Negative binomial model for pooled panel data. Separate gender results.	Demographics, income, marital & work status, education, smoking, drug use, etc. & state fixed-effects.	IRRs for prices are insignificant. Men & Women samples, prices are insignificant or positive.
Rhoads (2010)	BRFSS, 1991-2004. Age = 45 yrs. Subsamples for ages 25-39, 40-64 & 65+ yrs.	Any binge drinking in past 30 days (5+ drinks). No. of binge days in past 30 days (count data).	ACCRA wt ave. real price per ounce of ethanol,	Probit model for any binge participation. OLS model for frequency, but ignores count data feature.	Demographics, income, marital status, work status, education, cigarette tax, year fixed-effects, etc.	Participation, alcohol price is insignificant or positive. Frequency, price is negative & significant for 40-64 & 65+ yrs
Sloan et al. (1995)	BRFSS, 1984-90. Age = 34 yrs.	Any binge drinking in past 30 days. No. of binge days in past 30 days (5+ drinks).	ACCRA wt. ave. real price of alcohol at state level, expressed relative to California in 1990.	Two-part model: probit model for participation; Tobit or OLS models for frequency.	Demographics, education, legal age, income & 12 variables for drink-driving laws & enforcement.	Participation, alcohol price is insignificant. Frequency, price is negative & significant in tobit, but not in OLS model.
Stout et al. (2000)	BRFSS, 1984-95. 25% random sample for ages > 21 yrs. Age = 42.5 yrs.	Any binge drinking in past 30 days (5+ drinks).	ACCRA wt ave. real price of alcohol at state level, expressed relative to California in 1990.	Logit model for binge drinking & binge drinking & driving.	Demographics, income, education, health behavior, state features, outlet density, time trends & 17 variables for drink-drive laws	Alcohol price is insignificant for probability of binge drinking, given person is a drinker.
Terza (2002)	Alcohol & Health Practices suppl. to 1988 Health Interview Survey. Males, age = 40 yrs.	Individual exceeds sample 90% percentile of ethanol use in past 2 weeks. State "wetness" is per capita ethanol sales.	State beer tax.	Probit model. Two-part model for alcohol abuse (probit) & work status (MNL logit).	Demographics, health status, education, work status, parents' drinking, region, state "wetness," cigarette tax, etc.	Men, beer tax & its square are statistically insignificant.

Zhang (2010)	BRFSS, 1985-2002. Females, age = 30 yrs. (est.); age range < 44 yrs.	Any binge drinking by a pregnant woman in past 30 days (5+ drinks). Incidence is only 1.4%.	Federal & state real alcohol taxes for beer, wine & spirits. Excludes control states for spirits.	Two-part model: probit & OLS. Separate results reported for each tax rate by beverage.	Demographics, income, marital status, education, year & state fixed-effects.	Women, all three tax rates are negative & significant, with sizeable elasticities.
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NESARC = National Epidemiological Survey on Alcohol & Related Conditions.

Supplemental Table 4. Natural experiments and field interview studies: binge drinking and prices/taxes

Study	Data, Ave age (est.)	Alcohol measure	Price/tax measure	Methods	Controls	Results
Chung et al. (2013)	Hong Kong, special telephone surveys in 2006, 2011 & 2012. Age = 44 yrs.	Any binge drinking in past 30 days (5/4+ drinks). Also alcohol abuse & dependence variable.	Natural experiment, govt. excise tax cut of 50% in 2007 & 100% cut in 2008 on beer & wine.	Logistic model, with year effect for 2011 & 2012 compared to 2006 (odds greater than one is positive effect of cuts).	Demographics, marital status, work status, education & year. Binge reductions not due to global economic crisis.	Odds ratio less than one for 2011; insignificant for 2012. Prevalence fell from 2006 to 2011-12.
Clapp et al. (2003)	US, two telephone surveys of college students, 2000-01. Ages = 24 yrs. & 20 yrs.	Any binge drinking in the past 28 days (5+ drinks). Subjective rating for "felt drunk."	Free (no-cost) alcohol provided at event (private parties, bar, & public gatherings).	Discriminant factor analysis & path-analysis model. Exploratory-confirmatory analyses.	Environmental & personal factors for food, risk, bartender, drugs, BYOB, games, gender, etc.	Free alcohol not important for factor loadings & does not appear in path-analysis models.
Gmel et al. (2008)	Switzerland, four-wave telephone survey of 889 alcohol users, one pre- and 3 post-tax surveys. Age = 15-60+ yrs.	Drinkers divided into three groups by ethanol per day: high consumers are males > 40g & female > 20g.	Natural experiment, tax reduction of 9-50% on foreign spirits & 30-50% reduction on price of foreign spirits	Change in consumption of spirits & total alcohol. Three controls for regression to mean (RTM) & hierarchical linear model.	Demographics. Only those who remained drinkers are retained in sample. Time-points matter for drinking categories.	Adjusted for RTM, high-level drinkers increased consumption more in the short term, but effect was not lasting.
Gustafsson (2010); see also Makela et al. (2007)	Sweden, telephone survey during 2003, 2004, 2005& 2006. Age ranges: 16-49 yrs. & 50-80 yrs.	Binge drink is one or more bottles of wine, 5 drums of spirits, or 4-6 cans of beer. Identifies also top 10% of heavy drinkers.	Natural experiment, 45% decline in Danish tax on spirits (2003) & Swedish increase in travelers' allowance. 25% price reduction.	One yr. (03-04), two yr. (03-05) & three yr. (03-06) changes in ave. monthly consumption for binge drinkers & heavy drinkers.	Separate results for men & women, age, social class, south vs. north Sweden (control area).	Insignificant increase in ave. volume for bingers in S. Sweden. Insignificant increases for heavy drinkers, men vs. women & younger drinkers.
Heeb et al. (2003); Kuo et al. (2003)	Switzerland, telephone survey, 3 mths. before & 28 mths. after tax-change. Age = 15-29, 30-59 & 60+ yrs.	Any binge drinking in past 6 months (6/4+ drinks). Restricted to current drinkers.	Natural experiment, tax reduction of 9-50% on foreign spirits & 30-50% for price reduction on foreign spirits	OLS regressions, with bingers classified into stable drinker, increasers & decreaseers.	Any change in binge drinking on before/after basis for three age groups & males & females.	Some increase among men. Any changes were not significant controlling for age, sex, and volume.

Helakorpi et al. (2010); see also Mustonen et al. (2007)	Finland, Health Behaviour & Health Surveys, 1982-2008. Age = 45 yrs.; range 25-64 yrs.	Binge drinking at least once a week for men & once a month for women (6+ drinks).	Natural experiment, reduction by 33% in excise taxes in 2004 & increase in travelers' allowance.	Logistic model: age-adjusted odds ratios for 2003-08 & 2004-08.	Age, gender, & education attainment. Drinking increased more among 45-64 age group.	Men, binge increases for lowest group b/ education. Women, increases for highest group by education.
Jamison & Myers (2008)	UK, survey of UCL students, 2006. Age = 23 yrs.	Any binge drinking in a typical week (5/4+ drinks).	Prices are measured by "buying rounds" & anticipated behavior for "special offers."	Step-wise OLS. Mann-Whitney (M-W) tests for indep. groups for binge & non-binge drinkers.	Demographics, peer influence, intentions, attitudes, norms, school status, etc.	Prices do not appear in regressions. M-W test indicate bingers respond to special offers.
O'Mara et al. (2009)	US, random & self-selected students, bar district near large college campus, 4 nights in 2008. Age = 22 yrs. (est.).	Breath test (BrAC) to assess intoxication. Self-report on grams ethanol consumed & expenditures.	Mean est. cost per gram falls from \$0.23 for the BrAC < 0.08g group to \$0.16 for BrAC ≥ 0.08g group.	Logistic model, with fixed- and random-effects. Dep. variable is intoxication.	Gender, body mass, no. of drinks consumed on- & off-premise, intentions, etc.	On-premise cost is significant; & off-premise cost is not significant for intoxication.
Stockwell et al. (1993)	Australia, special household survey of drinking settings, 1990. Age = 25 yrs. (est.).	Any binge drinking in past 3 months (6/4+ drinks).	Price-discounting on drinks.	Step-wise logistic model for 321 drinkers with heaviest consumption and/or harm outcome.	Demographics, marital status, location, & drinking setting,	Price-discounting is insignificant for binge drinking & alcohol-harms.
Thombs et al. (2008, 2009)	US, random & self-selected students, bar districts near two large colleges for 4 nights, 2007. Age = 21 yrs.	Breath test (BrAC) to assess intoxication.	Three price measures: all-you-can drink at fixed price; drink game discounts; & reduced prices on specials.	Multivariate model, with random-effects for each bar.	Demographics, night of week, sampling status, etc. All-you-can-drink includes zeros for females.	Fixed price statistically significant. Other price promotions are not significant.
Wagoner et al. (2012)	US, Web-based survey of students at 10 colleges. Age = 20 yrs.	Any binge drinking in past 30 days (5/4+ drinks).	Variable for frequency of free drinks: never; seldom; & often.	Logistic model. Results for gender interactions with price.	Demographics, yr. in school, Greek status, relationship status, monthly allowance, etc.	Free drinks are positive-significantly associated with odds of bingeing for both genders.