

Alcohol Taxes and Beverage Prices

Abstract - Alcohol involvement in auto crashes, homicides, and teen drinking is an important policy concern, and the price of alcohol may have significant effects on these behaviors. Are alcohol taxes quickly and fully passed on to consumers? Given the difficulties of accurately measuring beverage prices, are beer taxes a good empirical proxy for the price of alcohol? Using pooled cross section-time series data on state and Federal alcohol taxes and beverage prices, beer taxes are found to be poor predictors of alcohol prices. Controlling for state and period effects, excise taxes appear to be over-shifted: Retail prices rise by more than the amount of the tax, and the rise occurs within 3 months.

INTRODUCTION

Alcohol involvement in auto crashes, homicides, and teen drinking is an important policy concern, and the price of alcohol may have significant effects on these behaviors. A number of studies have estimated relationships between alcohol taxes and/or prices on the one hand, and alcohol consumption, motor vehicle fatalities, and other outcomes on the other hand.¹ However, these studies have produced conflicting results, depending on whether taxes or prices are used to measure the cost of alcohol, whether these are for beer, wine, spirits or some combination, and other factors.² Studies that use taxes as a measure of the cost of alcohol implicitly assume that taxes are quickly passed on to consumers in the form of higher prices.

There has been little previous work on the relationship between alcohol taxes and beverage prices.³ This relationship is of interest for several reasons. First, the response of retail

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National Tax Journal
Vol. LV, No. 1
March 2002

¹ Recent examples include Benson et. al. (1999), Dee (1999), Mast et. al. (1999), and Young and Likens (2000). See Grossman et. al. (1993) for a broader discussion of revenue, politics, and external effects in alcohol and tobacco taxation.

² For example, Chaloupka et. al. (1993) find that higher beer taxes are associated with dramatically lower motor vehicle fatalities, particularly among youth. But Sloan et. al. (1994a) find a *positive* relationship between alcohol price and fatalities for ages 21-24, and a negative relationship for ages 25-64, but neither is significant.

³ Cook (1981) finds that increases in state taxes on liquor were marked up by 19 percent on the average from 1960-1975 in license states. (For each year and license state with a tax change in that year, he calculates the price change, subtracts that year's median price change, and divides the resulting net price changes by the tax changes in that year. The median of the 39 ratios is 1.1875.) The Executives' Alcoholic Beverage Newsletter International, February 10, 1989, reports an average markup of about 30 percent of the Federal spirits tax hike of 1985.

beverage prices to changes in alcohol taxes is one example of tax incidence analysis, and our results complement other recent studies in this area (see, for example, Besley and Rosen, 1999; Keeler et al., 1996; and Poterba, 1996). Second, tax policy can affect alcohol consumption and related behaviors only to the extent that prices do in fact respond to taxes. Thus, if only a small fraction of alcohol taxes are passed on to beverage prices, one would not expect tax changes to have much impact on behavior. Finally, taxes—especially beer taxes—have sometimes been used as empirical proxies for beverage prices, because of concerns about the quality of the available price data. This study assesses the quality of the price data, and considers whether beer taxes are a good empirical proxy for the cost of alcohol.

The evidence from this study indicates that alcohol taxes are over-shifted to consumers. For example, the Federal excise tax on beer increased by \$9 per barrel in 1991. It is estimated to have increased retail prices by \$15 to \$17. There is no detectable lag in the response of prices to taxes, so that the full effect of a tax change is experienced within three months. However, state beer taxes by themselves appear to be poor proxies for alcohol prices. Other dimensions of tax policy—especially spirits taxes—are highly significant and are more highly correlated with price than beer taxes. In addition, state taxes are only about 3–5 percent of retail prices. Consequently, studies that use beer taxes as the sole measure of price should be regarded with a great deal of caution.

THEORY—CAN PRICE RISE *MORE* THAN THE TAX?

Text book presentations of tax incidence theory usually conclude that the burden of an excise tax is shared between the

buyer and the seller, with the market price rising *at most* by the full amount of a tax whose legal liability is on the seller. However, recent extensions to the theory focusing on the implications of imperfect competition find that varying degrees of shifting are possible. In particular, the price of a taxed commodity can increase by more than the amount of the tax.

Under simple monopoly, for example, the amount of shifting depends on the shapes of the supply and demand curves. Indeed, if marginal cost is constant and the demand curve displays constant elasticity, then the price will always rise by *more* than the amount of the tax.⁴ To see this, recall the relationship between marginal revenue, price and elasticity:

$$MR = P\left(1 - \frac{1}{\varepsilon}\right),$$

where ε is the absolute value of the price elasticity of demand. If marginal cost (MC) is constant and the per unit tax rate is t , then profit maximization implies that $MR = MC + t$, so

$$P = (MC + t) \frac{\varepsilon}{\varepsilon - 1},$$

and thus that taxes are over-shifted for $\varepsilon > 1$.⁵ For example, if the price elasticity of demand is two, then price will rise by twice the amount of an excise tax.

Katz and Rosen (1985) and Besley (1989) analyzed tax shifting in an oligopoly setting. For example, Besley considers identical firms that produce a homogeneous good subject to a fixed cost and constant marginal cost. The shape of the demand curve is again crucial to the results: Price will always rise by more than the amount of the tax if the demand function is convex, as in the constant elasticity case.

Somewhat more generally, taxes will be over-shifted whenever the industry supply curve slopes downward. A falling in-

⁴ We thank Ron Johnson for pointing this out to us. See also Stiglitz (1988, p. 425).

⁵ The condition $\varepsilon > 1$ is required for a simple monopolist to be maximizing profits.

dustry supply curve could occur because of economies of scale at the firm level, industry “spillover” effects that reduce average costs as output expands, or a favorable factor price effect. In any case, quantity demanded falls when a tax is imposed, which in turn raises average total cost and the prices firms must charge to remain in business. Thus, price rises both because of the tax itself, and because per unit costs rise as quantity declines. The combination of the two effects means that the increase in price is larger than the tax itself.

Barzell (1976) provided an entirely different explanation for why price may rise by more than the amount of the tax: A per unit tax creates an incentive for producers to increase “quality” along untaxed dimensions. For example, Barzell found that cigarette producers responded to a tax levied on a per package basis by increasing the amount of tobacco per package, by offering longer cigarettes. Thus price rose both because of the tax increase, and because of the increased “quality” of the cigarettes.

The relevance of these models for alcohol taxation is not completely clear. The most appropriate model of the beverage industry is probably some form of monopolistic competition with differentiated products both across and within beverage types.⁶ To our knowledge the incidence of excise taxes in such a model has not been worked out. Barzell’s insight may be reflected in the mix of beverages that are offered and consumed, since the relative cost of low quality beverages is increased. However, spirits taxes, and to a lesser ex-

tent beer and wine taxes, are affected by the alcohol content of the taxed beverage, so it is not easy for the producer to avoid the tax by increasing the alcohol content. Also, interstate tax differentials may not be sufficiently large to justify the costs associated with producing different quality beverages for sale in different states. In any case, there is no evidence that the quality of the particular beverages for which we track prices have changed over time.⁷

We conclude that the theoretical literature indicates a variety of circumstances in which taxes may be over-shifted to retail prices and that an empirical study of a particular industry is necessary to investigate the incidence of a given tax hike.

MEASURING TAXES AND PRICES— CONCEPTUAL AND PRACTICAL ISSUES

Economic theory suggests that prices—rather than taxes—directly affect behavior, and thus that prices are the better indicators of the cost of alcoholic beverages. The available price data, however, contain substantial measurement error. Many studies use the price information collected by the American Chamber of Commerce Research Association (ACCRA) for its quarterly surveys of the cost of living in various cities around the U.S.⁸ The surveys report retail prices, exclusive of sales taxes, for specific beverages.⁹ However, the beverage definitions have changed over time, requiring adjustments to create a consistent time series.¹⁰ In addition, the data may

⁶ In 1990, Anheuser–Busch had a 45.9 percent share and Miller had a 23.1 percent share of the domestic market in the beer industry (see Cook and Moore, 1993).

⁷ See footnote 10 for a description of these beverages.

⁸ For examples, the ACCRA data were used in studies of alcohol consumption by Nelson (2000), Beard et. al. (1997), Kenkel (1993) and Gruenewald et. al. (1993), an analysis of traffic accidents, homicides, suicides and other deaths by Sloan et. al. (1994b), and in a study on alcohol-related fatalities by Young and Likens (2000).

⁹ Currently the beverages are a six pack of Budweiser or Miller Lite in 12 oz. containers, a 750 ml bottle of J&B Scotch, and a 1.5 liter bottle of Gallo or Livingston Cellars Chablis.

¹⁰ Beer: 1982.1–1989.3: Six pack of Budweiser or Schlitz.

Spirits: 1968.1–1988.3: Seagram’s 7–Crown, 750 ml; 1988.4–1989.3: J&B Scotch, 1 liter.

Wine: 1982.1–1983.3: Paul Maisson Chablis, 750 ml; 1983.4–1990.4: Paul Maisson Chablis, 1.5 liter; 1990.4–1991.3: Gallo Sauvignon Blanc, 1.5 liter. See the fourth section for the adjustments made in this paper.

not be consistent across states and over time because members of local chambers of commerce are responsible for collection and reporting. Beer and wine price data are only available since 1982. Finally, there are significant gaps in the data for various states and years.

Consequently, taxes could, in principle, be a better indicator of the prices consumers face than the available price data. However, taxes are also measured with error, particularly taxes on spirits. In 18 states liquor is sold through state stores and is subject to ad valorem markup and/or excise taxes. In these “control” states, the markup is in part a tax, because the state stores earn a profit, but it is difficult to determine the implicit tax rate from the normal costs of wholesaling and retailing liquor.¹¹ The remaining “license” states levy a per unit excise tax.¹² Tax rates also vary according to alcohol content, place or volume of production, size of container, place purchased (on- or off-premise), and there may be case or bottle handling fees.

These problems with price data in general and spirits and wine taxes in particular have led some researchers to conclude that beer taxes alone are the best available indicators of the cost of alcohol (see, e.g., Chaloupka, 1993, p. 169). However, beer tax data share some of the problems of spirits and wine data: Taxes vary by alcohol content (e.g., 3.2 beer vs stronger beer), size of container (e.g., cans vs barrels), on-premise vs off-premise, etc. Beer and other beverages are also subject to local taxes, which may vary by location within a state.¹³

Beer taxes (or prices) may also be a poor indicator of the overall price of alcohol, because beer consumption represents only about half of total alcohol consumption. Malt beverages constitute 87 percent of consumption measured in terms of gallons of beverage, but only about 56 percent in terms of consumption of pure alcohol (ethanol). Alcohol consumption in the form of spirits is more than 30 percent of the total, and wine more than 10 percent.¹⁴

State taxes may also be a poor measure of prices because they are a relatively small part of beverage prices, and other factors such as transportation cost, competitive environment, or local costs of distribution may be more important. For example, distance to a brewery plays an important role in beer pricing.

The following sections provide empirical evidence on the relationship between alcohol taxes and beverage prices. The next section utilizes a single cross-section of state tax and price data, while the following section pools 64 quarterly cross-sections.

ARE STATE TAXES A GOOD PROXY FOR PRICES?

Tables 1, 2, and 3 present data on state alcohol taxes and prices from the fourth quarter of 1997. Consider first the ACCRA price data in Table 1.¹⁵ The left side presents the data in “natural” units, i.e., as dollars per bottle or six pack, and the right side presents the prices in units of dollars per gallon of pure ethanol. There is a sig-

¹¹ Benjamin and Anderson (1996) investigate why some states use the control and some the license approach. Their explanation is based on an effort to minimize enforcement costs associated with spirits taxation in the post-Prohibition era.

¹² A similar but less severe situation occurs with wine: Five states “control” wine sales, while the remainder levy per unit excise taxes.

¹³ Strumpf and Oberholzer-Gee (1999) investigate why some states have tax rates which vary across local jurisdictions. They find that varying local tax rates are more likely to exist in states which have minority groups that feel more strongly about spirits.

¹⁴ Source: Beer Institute (1997), Tables 38, 40 and 42. Based on 1990 consumption, and alcohol content of: spirits – 40 percent, beer – 4.5 percent, and wine – 11 percent.

¹⁵ State level data are calculated by averaging the figures from one or more cities within each state. The sample includes 47 states plus Washington DC. The means reported in the table are simple averages of the state figures.

nificant amount of inter-state variation in prices, as indicated by the range of observed prices.¹⁶

State taxes are only a very small part of retail prices (Table 2).¹⁷ State excise taxes constitute only about 4 percent of spirits prices, 5 percent of wine prices, and 3 percent of beer prices. The average state excise tax on a gallon of pure ethanol is \$6.50, which is about 3.5 percent of the average price.¹⁸

Correlations between the individual beverage prices and taxes are not very high, even for each beverage's own tax

(Table 3).¹⁹ The tax on beer is actually negatively correlated with the price of beer. The correlations of the beer tax with the other prices are also small, and only .03 with the alcohol price index. In fact, the beer tax has the lowest correlation with the price of alcohol of any of the taxes.

These results suggest that state alcohol taxes are not good indicators of beverage prices. State excise taxes are only 3 to 5 percent of retail prices, and correlations between the taxes and prices are very low. Beer taxes are especially poor indicators of prices.

TABLE 1
ALCOHOL PRICES

	per Bottle or Six Pack				per Gallon of Ethanol			N
	Unit	Mean	Min	Max	Mean	Min	Max	
SPIRITS	750ml	\$18.35	\$15.07	\$22.05	\$231.50	\$190.13	\$278.24	48
WINE	1.5l	\$5.73	\$4.62	\$6.80	\$131.42	\$105.91	\$156.04	48
BEER	6-12oz	\$4.35	\$3.73	\$5.38	\$171.97	\$147.28	\$212.50	48
ALCOHOL					\$185.86	\$163.67	\$222.31	48

Notes: Data are for 50 states and DC in 1997:IV.

Missing: Hawaii, Maine, and New Jersey. New Hampshire data are for 1997:I.

Price per Gallon of Ethanol Based on Alcohol by Volume: Spirits – 40%, Wine – 11%, Beer – 4.5%

Alcohol Price Based on (1990) Consumption Shares: Spirits – 31.5%, Wine – 12%, Beer – 56.4%

TABLE 2
STATE ALCOHOL TAXES

	per Bottle or Six Pack				per Gallon of Ethanol			N
	Unit	Mean	Min	Max	Mean	Min	Max	
SPIRITS	750ml	\$0.72	\$0.30	\$1.29	\$9.05	\$3.75	\$16.25	33
WINE	1.5l	\$0.29	\$0.04	\$0.89	\$6.76	\$1.00	\$20.45	46
BEER	6-12oz	\$0.14	\$0.01	\$0.52	\$5.42	\$0.44	\$20.67	51
ALCOHOL					\$6.50	\$2.70	\$17.89	33

Notes: See Notes to Table 1.

Missing: Spirits and Alcohol—18 Liquor Control states (Alabama, Idaho, Iowa, Maine, Michigan, Mississippi, Montana, New Hampshire, North Carolina, Ohio, Oregon, Pennsylvania, Utah, Vermont, Virginia, Washington, West Virginia, Wyoming).

Missing: Wine – 5 Wine Control States (Mississippi, New Hampshire, Pennsylvania, Utah, Wyoming).

¹⁶ Wine is the cheapest, then beer, and spirits are the most expensive. However, these reflect the relative quality of the particular brands sampled by ACCRA: J&B Scotch is a fairly high quality spirits beverage, while Gallo Sauvignon Blanc is not of the same standing among wines. CPI data based on “all malt beverages” for beer, vodka for spirits, and “table” wine—reverse the ordering: spirits are the cheapest, then beer, and finally wine.

¹⁷ The 18 liquor control states are excluded from the spirits calculations, and similarly for the five wine control states. Maryland is treated as a license state, even though Montgomery County operates as a control jurisdiction.

¹⁸ The highest excise taxes are on spirits, then wine, and the lowest on beer. The differences are not a function of the quality of the particular products, since these taxes are specified per unit of beverage, rather than as a percentage of the price.

¹⁹ Sample sizes vary by cell because of missing price and tax data. For example, the correlation between beer prices and spirits taxes is calculated using data just from those states that report both beer prices and spirits taxes.

TABLE 3
PRICE-TAX CORRELATIONS

		PRICES				TAXES			
		SPIRITS	WINE	BEER	ALCOHOL	SPIRITS	WINE	BEER	ALCOHOL
PRICES	SPIRITS	1.00							
	WINE	0.35	1.00						
	BEER	0.23	0.45	1.00					
	ALCOHOL	0.74	0.61	0.82	1.00				
TAXES	SPIRITS	0.20	0.19	0.12	0.21	1.00			
	WINE	0.36	0.25	0.01	0.26	0.61	1.00		
	BEER	0.22	0.20	-0.18	0.03	0.60	0.60	1.00	
	ALCOHOL	0.28	0.26	0.10	0.24	0.81	0.77	0.93	1.00

Notes: See Notes to Tables 1 and 2. Sample sizes vary by cell.

EVIDENCE FROM POOLED DATA

Alcohol taxes are only loosely related to prices in a single cross section, but changes in taxes over time might still be good predictors of changes in prices. This depends—in part—on whether taxes are rapidly and fully shifted forward to consumers. It is also possible that the low tax-price correlations across states are a result of measurement error in the price data. These issues are addressed using quarterly data from 1982.1 to 1997.4 across the states and Washington, DC.²⁰ Federal excise taxes have been added to the state taxes.²¹

Are ACCRA Data Consistent with the CPI?

One way of assessing the quality of the ACCRA price data is to compare them with CPI data. The latter are not available by state, so national averages of the ACCRA data are computed (Figure 1).²² The ACCRA prices of beer, spirits and the alcohol index each rose approximately 50 percent by the end of 1997, which closely

matches the corresponding CPI data for alcoholic beverages at home.²³

The ACCRA data refer to store prices for off-premise (“Home”) consumption, but about one third of alcohol is consumed on-premise (“Away”), in restaurants and bars (ibid., p. 29). The ACCRA price index is close to the CPI index for Home consumption (correlation = .99), but the CPI price of consumption Away from home rose about 85 percent faster over the sample period (Figure 2).

Figure 3 displays average beer taxes along with the ACCRA alcohol and CPI – Home indices. The 1991 increase in the Federal beer tax is clearly evident. Overall, however, beer taxes do not track alcohol prices at all well.

We conclude that the ACCRA data do a good job of tracking the price of home consumption, but trends in beer taxes are only weakly related to trends in prices. On the basis of the CPI data, using beer taxes as a proxy for alcohol prices would provide a very poor fit, while the ACCRA data do much better.

²⁰ The primary source for the tax data is Distilled Industry Council of the U.S. (1999). There are a few discrepancies with the history provided in Brewers Association (1997), mostly regarding the month in which a tax change took effect. There are substantial gaps in the price data for various states in various periods that reduce the sample size.

²¹ Federal excise tax data are from the U.S. Bureau of Alcohol, Tobacco, and Firearms web page: <http://www.atf.treas.gov/alcohol/stats/index.htm>.

²² The ACCRA data are scaled so that 1982–84 = 100, in order to make comparisons with the CPI.

²³ The CPI values in December, 1997 were 147.2, 151.2, and 148.4, respectively (US BLS, 1998, p. 48). However, the ACCRA price index for wine shows a rise of only about 30 percent, while the CPI index rises to 143.0.

Figure 1. Alcohol Price Indices—ACCRA Data

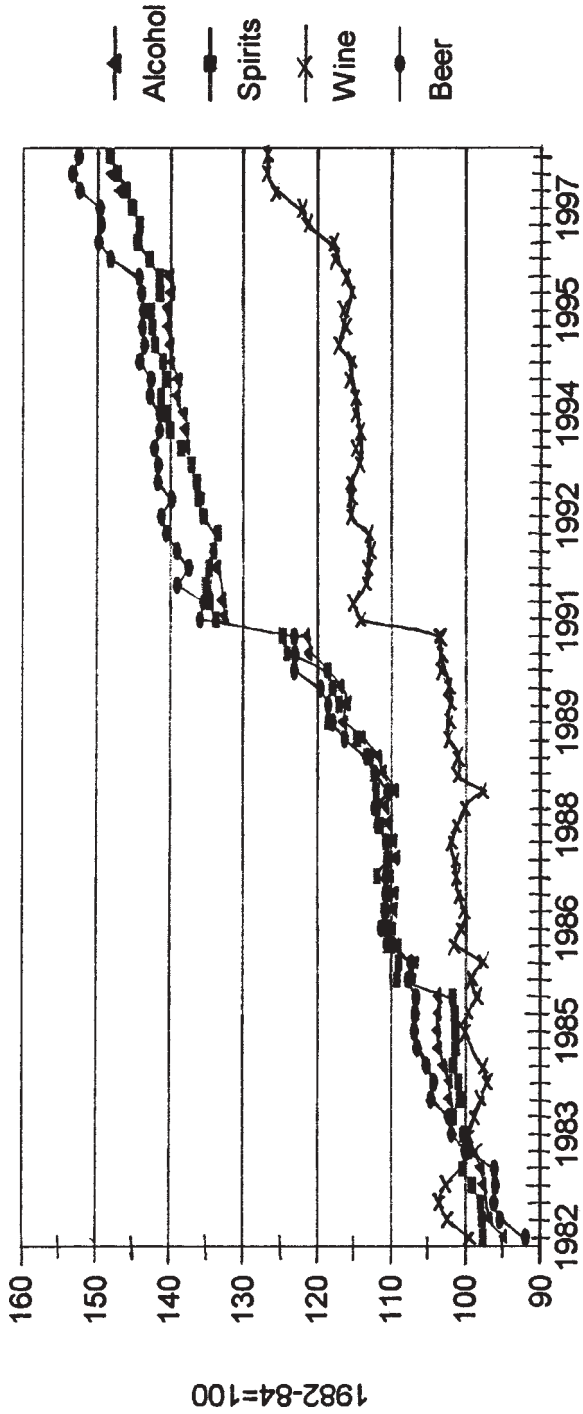


Figure 2. Alcohol Price Indices—ACCRA and CPI Data

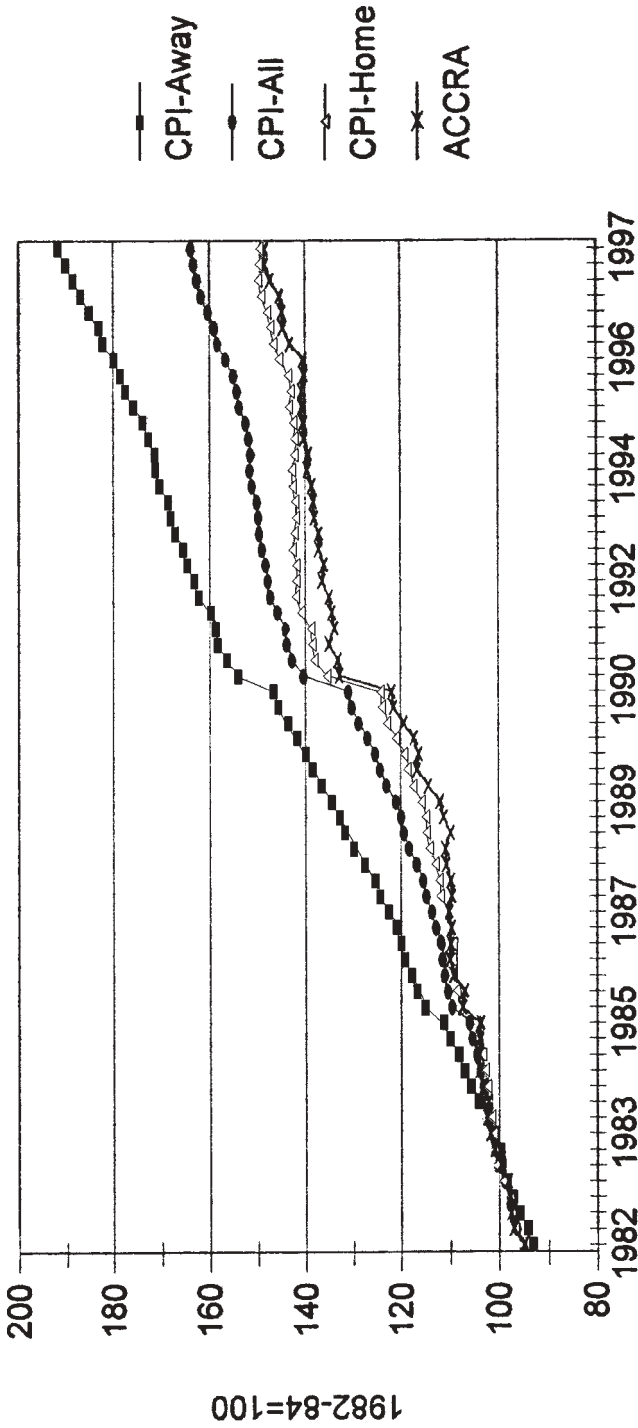
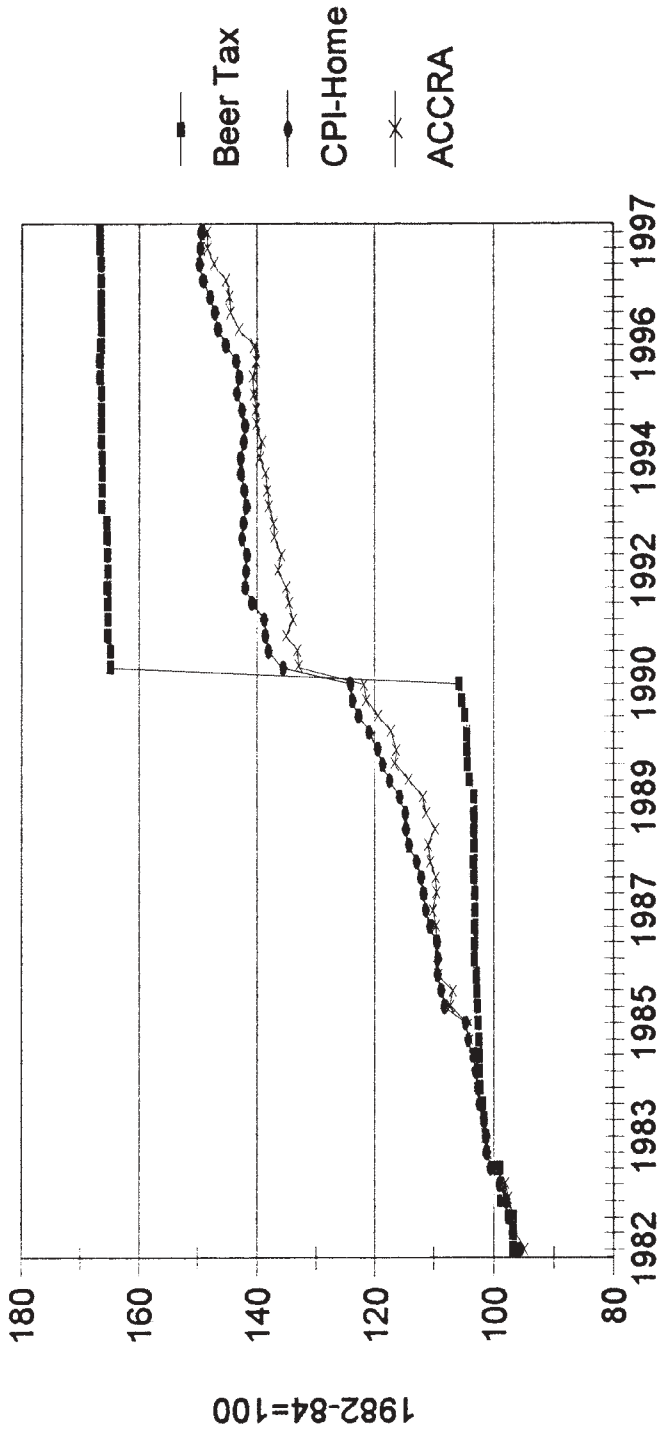


Figure 3. Beer Taxes and Beverage Prices—ACCRA, CPI and Beer Tax Data



Are Alcohol Taxes Good Predictors of Beverage Prices? Are Taxes Fully and Rapidly Shifted Forward to Consumers?

Tables 4–7 report regressions of beverage prices on alcohol taxes.²⁴ The basic model is of the form:

$$p_{it} = \beta r_{it} + \alpha_i + \gamma_t + \varepsilon_{it},$$

where: p_{it} is the price of alcohol in state i in period t , in dollars per gallon of pure ethanol, and r_{it} is the combined state and Federal excise tax rate in state i in period t , in dollars per gallon of pure ethanol.²⁵ Most of the regressions also contain state and time specific fixed effects (constant terms), α_i and γ_t . The fixed effects control for unmeasured factors that may be correlated with the tax variables and thus bias the estimates.²⁶ If taxes are fully shifted forward to consumers and taxes are measured without error, then the tax coefficient is expected to be close to one. A coefficient greater (less) than one implies that prices rise by more (less) than the amount of the tax, i.e., over- (under-) shifting.²⁷

Column (1) of Table 4 reports estimates without the fixed effects; that is, with a common intercept term across states and time. The R^2 is only .03, indicating that beer taxes explain only 3 percent of the

variation in beer prices. The estimated tax coefficient is .409.

Column (2) adds fixed effects for each state and time period. The R^2 increases to .79, so the fixed effects explain a great deal of the variation in prices. Beer taxes explain about 10 percent of the variation in beer prices that remains after the fixed effects have been accounted for.²⁸ The coefficient on the beer tax increases to 1.74, implying that beer taxes are over-shifted to retail prices.

The estimated serial correlation coefficient $\rho = .76$ indicates strong serial dependence. One possibility is that the disturbances are serially correlated. Alternatively, the large value of ρ could result from slow adjustment of prices to changes in tax rates. The two hypotheses can be distinguished as follows: If prices adjust slowly to tax changes, then lagged values of the tax variables will be significant. However, if serial correlation of the disturbances is the cause, the lagged tax variables will not be insignificant.

Column (3) includes four lagged values of the beer tax, and column (4) restricts these coefficients to be zero.²⁹ The F statistic for these restrictions is only .47, while the .05 critical value for $F(4, \infty)$ is 2.37. Thus, the lagged tax variables are not even close to significance, and the results suggest that taxes are quickly shifted forward to prices.

²⁴ Spirits and wine beverage definitions vary over time (see footnote 10). They are linked by requiring the change in the national average price to match the quarterly change in the detailed CPI for that beverage. For example, the spirits beverage in 1988.3 was 750ml Seagrams 7, and in 1983.4 it was 1,000ml J&B. The CPI values for spirits for the two periods were 116.5 and 116.9, a ratio of 1.00343. Thus, the ACCRA data prior to 1983.4 are multiplied by a factor which results in the same .343 percent change during the transition. Time specific dummy variables included in the fixed effects regressions absorb any problems in the linking procedure.

²⁵ Prices and taxes have been converted to 1997.4 dollars using the consumer price index for all urban consumers. This is consistent with the typical empirical approach, which relates alcohol-related outcomes to real incomes, prices, and other determinants. Expressing total alcohol consumption from different beverages in terms of pure ethanol is common in the literature. See, e.g., Nelson and Moran (1995) and Nelson (1997, 2000).

²⁶ See e.g., Dee (1999), Ruhm (1996) and Young and Likens (2000) in the context of motor vehicle fatalities, and Besley and Rosen (1999) in tax-price equations.

²⁷ All computations were performed using LIMDEP 7.0.

²⁸ This figure is calculated as follows: 1) Regress beer prices on the fixed effects and save the residuals. 2) Regress beer taxes on the fixed effects and save the residuals. 3) Compute the (squared) correlation between the price and tax residuals.

²⁹ The set of observations for which there are complete data on all four lags of the tax variable is smaller than the full data set; hence, the estimated coefficients differ between columns (2) and (4).

TABLE 4
BEER PRICE

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	167.4 (186.)	—	—	—	—	—
Beer Tax	.409 (8.9)	1.74 (16.7)	1.05 (1.6)	1.86 (15.9)	1.52 (2.7)	1.71 (4.8)
Beer Tax [-1]			.79 (1.1)		-.07 (.1)	
Beer Tax [-2]			.16 (.3)		.22 (.6)	
Beer Tax [-3]			-.04 (.1)		-.06 (.2)	
Beer Tax [-4]			-.12 (.4)		.16 (.5)	
Fixed Effects?	No	Yes	Yes	Yes	Yes	Yes
Est. Rho	.87	.76	.74	.74	.74	.74
Corrected for serial correlation?	No	No	No	No	Yes	Yes
F for Restrictions: Lagged Coefficients = 0				.47		.17
Critical value (95%)				2.37		2.37
R ²	.03	.79	.80	.80	.32	.31
N	2891	2891	2643	2643	2601	2601

Notes: Dependent variable is the price of beer. Price and the beer tax are measured in units of 1997.4 dollars per gallon of pure ethanol. Lagged values are indicated by [-1], [-2], etc. Fixed effects include dummies for each state and DC, and for each time period. Sample period is 1982.1-1997.4. Data are missing for various states in various time periods. Estimates are weighted by the number of cities reporting in each state-time period. Absolute values of t-statistics are shown in parentheses.

Columns (5) and (6) perform the same test for significance of the lagged tax variables, but after transforming the data to correct for serial correlation.³⁰ The F statistic is even smaller (.17) in the transformed data. The estimated beer tax coefficient remains well in excess of one, although the correction for serial correlation has the common effect of reducing the t-ratio.

These results suggest three conclusions about the relationship between beer taxes and beer prices. First, taxes appear to be more than fully passed on to retail prices, as indicated by tax coefficients well in excess of one. Second, taxes appear to be fully passed through to prices within the one quarter time period available in the data. Finally, beer taxes are not good predictors of beer prices, whether or not fixed

effects are included. There are systematic differences in prices across states and over time, as indicated by the explanatory power of the state and time effects. However, beer taxes are not a good empirical proxy for these price variations. These conclusions are all unaffected by corrections for serial correlation.

Table 5 presents similar results for spirits prices. One would not necessarily expect *spirits* prices to respond one for one with taxes on *beer*. However, tax rates on the different beverages are positively correlated across states (Table 3), and beer taxes have been used in several studies to represent the price of all alcohol, so the relationship is of interest. Column (1) indicates that beer taxes explain only about 5 percent of the variation in spirits prices. Fixed effects again markedly increase the

³⁰ The sample size again falls, because some observations are lost when the data are transformed.

TABLE 5
SPIRITS PRICE

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	229.8 (207.)	—	176.4 (72.7)	—	—	—
Beer Tax	.718 (12.7)	.079 (.6)				
Spirits Tax- License			1.49 (25.7)	3.01 (21.1)	2.82 (16.7)	1.64 (3.3)
Spirits Tax- Control			1.33 (22.5)	2.87 (14.8)	2.72 (12.1)	1.61 (2.7)
% Spirits Tax			.615 (16.5)	1.51 (10.7)	1.47 (9.8)	1.56 (3.5)
Spirits Markup			.498 (17.0)	.246 (6.1)	.23 (5.6)	.53 (4.9)
Fixed Effects? Est. Rho	No .89	Yes .95	No .88	Yes 1.0	Yes .92	Yes .92
Corrected for serial correlation?	No	No	No	No	No	Yes
F for Restrictions: Lagged Coefficients = 0					.84	.75
Critical value (95%)					1.64	1.64
R ²	.05	.77	.30	.81	.82	.23
N	2891	2891	2891	2891	2643	2601

Notes: Dependent variable is the price of spirits. See notes to Table 4.

explanatory power of the regression (Column (2)). As the low t-statistic indicates, beer taxes are not significantly correlated with spirits prices when state and time effects are included.³¹

Columns (3) and (4) employ spirits taxes to explain spirits prices. Not surprisingly, spirits taxes do a much better job of explaining spirits prices than do beer taxes: The R² (without fixed effects) is 30 percent versus 5 percent using beer taxes.³² Column (4) adds the state and time fixed effects, which again have substantial explanatory power.

The spirits data also display substantial serial dependence, and so the same test for significance of the lagged tax variables is performed. As indicated in column (5), the restriction that four lags of the spirits tax variables are all zero can not be rejected: the F statistic is only .84 while the 5 percent critical value is 1.64. The same conclusion is reached after correction for serial correlation (Column (6)). Although the magnitude and precision of the per unit tax coefficients decline after correction for serial correlation, they remain well above one.

³¹ Beer taxes explain less than 1 percent of the variation in spirits prices that remains after controlling for fixed effects. See footnote 28.

³² Per unit excise taxes are entered separately for license and control states, but their estimated effects are quite similar. A test of equality between license and control states yields an F statistic of 1.35 when fixed effects are included. The 5 percent critical value is 3.84, so equality would not be rejected. However, it is rejected for wine and alcohol (see below), so separate coefficients are retained for license and control states.

Thus, the spirits results echo the findings for beer: Beer taxes are a poor predictor of spirits prices and, while spirits taxes do considerably better, state and period effects are important as well. Per unit excise taxes are over-shifted to consumers; indeed, the coefficient magnitude is strikingly similar to that for beer at about 1.6 to 1.7 (after correction for serial correlation). And prices appear to fully respond to tax changes within one quarter.

The results for wine are broadly similar (Table 6). Beer taxes are a poor predictor of wine prices ($R^2 = .01$) and wine taxes

are better ($R^2 = .06$). Fixed effects again have substantial explanatory value. Lagged values of the tax variables are insignificant, indicating that prices adjust fully within one quarter. After correction for serial correlation, the point estimates of the tax coefficients for the license and control states fall to 1.24 and 2.11, respectively, again indicating that taxes are over-shifted to prices.³³

The alcohol price index is examined in Table 7. Beer taxes alone explain about 5 percent of the variation in alcohol prices (column (1)).³⁴ When spirits and wine tax

TABLE 6
WINE PRICE

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	133.7 (113.)	—	136.2 (157.)	—	—	—
Beer Tax	.350 (5.8)	1.15 (8.6)				
Wine Tax – License			.204 (3.8)	2.44 (17.1)	2.17 (15.4)	1.24 (2.9)
Wine Tax – Control			.017 (.1)	1.98 (11.7)	1.73 (10.6)	2.11 (4.4)
% Wine Tax			1.41 (12.1)	1.63 (12.0)	1.13 (6.8)	.26 (.69)
Wine Markup			.114 (2.3)	.363 (7.8)	.32 (6.9)	.24 (2.0)
Fixed Effects? Est. Rho	No .89	Yes .72	No .88	Yes .75	Yes .82	Yes .82
Corrected for serial correlation?	No	No	No	No	No	Yes
F for Restrictions: Lagged Coefficients = 0					.69	1.39
Critical value (95%)					1.64	1.64
R ²	.01	.80	.06	.82	.82	.22
N	2891	2891	2891	2891	2643	2601

Notes: Dependent variable is the price of wine. See notes to Table 4.

³³ The hypothesis that the license and control tax coefficients are equal is rejected whether or not one corrects for serial correlation. F statistics for equality in columns (4) and (6) are 8.53 and 6.80, while the critical value is 3.84.

³⁴ Beer taxes explain less than 7 percent of the variation in the alcohol price index that remains after controlling for fixed effects. See footnote 28.

TABLE 7
ALCOHOL PRICE

	(1)	(2)	(3)	(4)	(5)
Constant	183.1 (229.)	—	144.2 (77.0)	—	—
Beer Tax	.497 (12.2)	1.14 (13.9)	.29 (4.9)	.099 (.9)	.36 (1.7)
Spirits Tax – License			.93 (21.1)	1.53 (14.1)	.68 (2.0)
Spirits Tax – Control			.83 (19.4)	1.97 (13.4)	.73 (1.8)
% Spirits Tax			.21 (6.0)	.402 (4.1)	.52 (2.0)
Spirits Markup			.18 (7.6)	.024 (.9)	.16 (2.4)
Wine Tax – License			.16 (3.5)	.896 (7.1)	.65 (1.8)
Wine Tax – Control			1.18 (7.9)	.621 (5.3)	.52 (1.4)
% Wine Tax			1.30 (17.4)	.689 (6.8)	.36 (1.2)
Wine Markup			.005 (.2)	.087 (2.5)	.10 (1.2)
Fixed Effects? Est. Rho	No .91	Yes .84	No .89	Yes .83	Yes .83
Corrected for serial correlation?	No	No	No	No	Yes
R ²	.05	.84	.30	.87	.32
N	2891	2891	2891	2891	2770

Notes: Dependent variable is the price of wine. See notes to Table 4.

variables are included, the explanatory power rises to 30 percent (column (3)). Fixed effects are highly significant, and when they are included the beer tax is no longer statistically significant. In contrast, the spirits and wine taxes are significant, except for the markup variables (column (4)).

Over-shifting is more difficult to assess using the alcohol price index, but it appears to be true of spirits and wine taxes. For example, the spirits tax coefficient for license states in column (5) is .68. Since spirits consumption is only about 30 percent of alcohol consumption, this suggests that a spirits tax increase of \$1 results in a

spirits price increase of more than \$2. Alternatively, an increase in spirits taxes may result in increases in all alcohol prices as consumers substitute among beverages.

CONCLUSION

We find that beer, spirits, and (more weakly) wine taxes are over-shifted to retail prices: The estimates indicate that prices rise by significantly more than the rise in excise taxes. Keeler et. al. (1996) also found over-shifting of cigarette taxes, although the magnitude was smaller. Besley and Rosen (1999) found over-shifting for some commodities, but Poterba (1996) did

not. Both of the latter studies examined retail sales taxes, while excise taxes are considered here. The effect of an excise tax increase might differ from that of a general sales tax hike for several reasons. First, market structure may differ among beer, spirits, and wine, and in comparison with retail sales in general. Second, a general sales tax would have a more limited substitution effect on demand than an excise tax limited to alcohol, because there are many substitutes for alcohol and especially for beer, wine, and spirits separately. Third, a general sales tax would have a much larger income effect on demand, because alcohol is a relatively small part of most people's expenditure. How these differences may affect shifting is hard to predict *a priori*.

We find that prices fully respond to tax changes within the three month interval available in these data. Thus, there is no evidence of an extended adjustment period. Although Besley and Rosen (1999) find evidence of partial adjustment for some commodities, the mean lag length is only about three months. Thus, they are in substantial agreement with the conclusion of this study that taxes are "quickly" passed on to prices.

We find that alcohol taxes—and especially beer taxes—are poor measures of beverage prices. State alcohol taxes are a relatively small part of retail prices (about 3–5 percent), and the tax structures are very complex: Rates differ by type of beverage (spirits, wine or beer), and by many other characteristics, including alcohol content and container size. Indeed, the very structure of alcohol taxation differs between control and license states. Consequently, there is no single tax rate which accurately measures alcohol taxes.

The problem is particularly acute when the beer tax is the sole variable employed to measure the price of alcohol. Beer taxes explain only about 5 percent of the variation in prices, and spirits and wine taxes also affect the price of alcohol—indeed

they have considerably more explanatory value than do beer taxes. Beer taxes do not track CPI data well, while the ACCRA price data reproduce national trends remarkably accurately. As a result, studies that use beer taxes as the sole measure of the price of alcohol should be regarded with caution.

The results have mixed implications for the effectiveness of raising taxes as a method of affecting alcohol consumption and related behaviors. On the one hand, we find that an increase in taxes results in an even larger increase in price by the time it reaches the retail level. On the other hand, state taxes are such a small percentage of retail prices that it would require quite large increases in taxes to have much effect on prices. For example, if an average state doubled its excise tax on beer to 28 cents a six-pack, the retail price would be expected to rise by 23.8 (=14*1.7) cents or only about 5 percent (all in 1997 dollars). The ultimate effect on behavior would depend in turn of the price elasticity of demand.

Acknowledgments

Timothy Besley, Ron Johnson, William Mikhail, an anonymous referee, and especially the Editor of this *Journal* provided helpful comments and discussion.

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