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ARE ALCOHOL EXCISE TAXES OVERSHIFTED TO PRICES? SYSTEMATIC REVIEW AND META-ANALYSIS OF EMPIRICAL EVIDENCE FROM 29 STUDIES

Jon P. Nelson and John R. Moran

This paper conducts the first comprehensive review and meta-analysis for estimates of alcohol tax pass-through rates. The review examines data coverage by country; econometric models; and results for under- or overshifting by beverage. Several primary studies indicate substantial overshifting of alcohol taxes. Median rates also suggest taxes are overshifted. Precision weighted-averages calculated for two samples show beer taxes are overshifted and wine-spirits taxes are fully shifted. Meta-regressions corrected for publication bias indicate, however, that full-shifting of alcohol taxes cannot be rejected for any beverage. Results are useful for alcohol tax policy and future research on tax incidence.

Keywords: tax incidence; excise taxes; alcohol; meta-analysis

JEL Codes: H22, I18, C54

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ARE ALCOHOL EXCISE TAXES OVERSHIFTED TO PRICES?

I. INTRODUCTION

Alcohol excise taxes are used as a revenue source at state and federal levels, making assessments of tax incidence an important fiscal policy issue (Lowry, 2014). Higher alcohol taxes also are frequently advocated as a cost-effective policy for addressing heavy or harmful drinking and related damages to health, property, and general well-being (Babor et al., 2010; Cook, 2007; Kenkel and Manning, 1996). At the federal level, nominal tax revenues from U.S. alcohol sales increased from $2.2 billion in 1950 to $9.6 billion in 2015. However, revenues in constant dollars declined by 55 percent. Similar declines in real revenues from state alcohol excise taxes have occurred.[1] A frequent issue is that federal and state tax rates are not indexed to inflation and rarely raised meaning that alcohol products have become more "affordable," thus creating controversy over the aims of tax policy (Kerr et al., 2013; Naimi et al., 2018; Nelson, 2014). A temporary reduction in U.S. federal taxes on alcohol in December of 2017 added to this controversy. However, it is often argued that taxes are overshifted; i.e., alcohol prices rise by more than the tax. Tax burdens borne by consumers therefore may be larger than the tax alone. If taxes are overshifted, externality-correcting taxes potentially will be too large and if undershifted, too small. Both outcomes create adverse welfare losses for society. Overshifting also adds to debate about regressivity of excise taxes. These concerns indicate the importance of empirical estimates of pass-through rates to retail prices for alcohol beverages, brands, and consumers. This paper provides the first comprehensive review of estimates of alcohol tax pass-through rates from 29 empirical studies and tests statistically for overshifting.

[1] According to Brookings' Tax Policy Center (2018), state and local revenues from alcohol taxes were $7.0 billion in 2015. About half of the states earmark a portion of revenues for specific programs (Perez, 2008). For international comparisons, see Anderson (2010, 2014) and Hines (2007). Many major wine-exporting countries do not tax wine.

In broad discussions of alcohol policy, higher alcohol taxes are often advocated regardless of incidence or regressivity. Babor et al. (2010, p. 109) assert that "economic studies conducted in many developed and some developing regions of the world have demonstrated that increased alcohol taxes and prices are related to reductions in alcohol use and related problems." The authors discuss evidence supporting their assertion, claiming that higher taxes "are among the most cost-effective ways for a government to reduce alcohol-related harm in both developed and developing countries" (Babor et al., 2010, p. 125). This argument also occurs in various reports by the World Health Organization; e.g., WHO's Global Strategy states that "increasing the price of alcoholic beverages is one of the most effective interventions to reduce harmful use of alcohol" (WHO, 2010, p. 16). Further, this claim is repeated often in alcohol policy literatures (e.g., Cook, 2007; National Research Council, 2004; Public Health England, 2016). In line with these proposals, numerous studies provide estimates of optimal alcohol excise taxes.[2] The studies address several issues for which empirical evidence must be marshalled and assessed. First, evidence must be compiled for social costs of alcohol use, both external costs and some portion of internal costs borne privately by consumers who might be ill-informed or short-sighted. Distinctions between externalities and internalities are important as are measurement of costs regardless of category (Clarke, 2008; Heien, 1995/96; Marron, 2015). Second, evidence is required on price elasticities of alcohol consumers, including drinkers whose consumption is categorized as heavy, abusive or harmful. Mixed evidence exists whether heavy and moderate drinkers have similar price elasticities (An and Sturm, 2011; Ayyagari et al., 2013; Nelson,

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[2] Optimal alcohol taxes address the trade-off between external costs avoided and higher costs imposed on moderate drinkers as taxes increase (Pogue, 2005). Optimal tax estimates include: Aronsson and Sjogren (2010); Cnossen (2008); Cook and Moore (1994); Fogarty and Parameswaran (2017); Griffith et al. (2017); Herrnstadt et al. (2015); Kenkel (1996); O'Donoghue and Rabin (2006); Pogue and Sgontz (1989); and Shrestha (2016). See Conlon and Rao (2016), and Fogarty and Parameswaran (2017) for discussion of welfare implications of overshifting of taxes.

2015a; Nelson and McNall, 2017; Xuan et al., 2015). Third, evidence is required on pass-through rates of excise taxes to retail prices for alcohol beverages.[3] Optimal tax studies assume full pass-through of taxes and typically cite a few empirical studies for support. Sometimes it is mentioned that some incidence studies support overshifting or that there is substantial heterogeneity of reported rates, suggesting that full pass-through is a conservative assumption.

The objective of the review is to provide a detailed examination of empirical evidence on alcohol tax pass-through rates, including quantitative tests of overshifting as a general outcome; i.e., average rates greater than unity. A systematic review is presented for 29 studies of pass-through rates for taxes on one or more beverages (beer, wine, distilled spirits). The review assesses variation in rates for each beverage and provides weighted-averages using meta-analysis. Several early U.S. studies are reviewed as well as recent studies that utilize improved microdata and more advanced econometric methods. Fifteen of 29 studies have a publication or release date after 2012. Using microdata, recent studies delineate pass-through rates by alcohol brand, price level, retailer location, store type, and consumer cohorts. The narrative review seeks to identify key empirical results and advances in empirical methods that might provide guidance to policymakers and future researchers. A narrative review also provides insight and evidence on heterogeneity of pass-through rates due to both differences across beverage markets and methodologies used in primary studies. For example, several recent studies analyze effects of tax hikes on cross-border price differences. Tax "leakage" and other unexpected consequences are a frequent concern when increases in alcohol taxes are proposed as a public health policy (LoPiccalo, 2016). In addition to a narrative review, a quantitative meta-analysis is conducted to

[3] Pass-through rates also are required in empirical demand studies to convert tax elasticities to average price elasticities (Cook, 2007, p. 72). Alcohol beverages have inelastic demands at the beverage level, which enhances revenue-raising objectives of taxes and reduces welfare costs (Ramsey rule) but limits its role in externality corrections; see Nelson (2013). In general, cross-price elasticities among alcohol beverages are small.

summarize pass-through rates for two samples of numerical estimates. The objective of the meta-analysis is to provide benchmarks estimates for average pass-through rates. We document the extent of under- or overshifting found in empirical studies and provide several weighted-averages by beverage. The analysis also empirically tests the null hypothesis that pass-through rates do not differ significantly from unity. Given heterogeneity of data and methods, both common (fixed effect-size) and plural (random effects-size) averages are reported, with emphasis on the latter.[4] Variation in rates for each beverage are examined further using meta-regressions corrected for publication selection bias.

The remainder of the paper is organized as follows: Section II provides a brief discussion of theoretical models that underlie incidence analysis. Numerous studies rely on imperfect markets as a cause of overshifting, but other explanations are possible such as menu costs of price adjustments. Recent theoretical studies focused on alcohol also are examined. Section III contains the narrative review. First, we discuss procedures used for discovery and assembly of primary studies. Second, benchmark reduced-form econometric models are presented. Third, we present a tabular summary of pass-throughs by beverage and study, while Appendix A (on-line) provides a more detailed analysis for each of 29 studies. The narrative seeks to pinpoint unique features of each study and common features across studies or subsets of results. Basic result(s) in each study are summarized, indicating under- or overshifting of taxes. Median estimates for each beverage are reported. Section IV provides meta-analyses for two samples of estimates. For 24 of 29 primary studies, both point estimates and standard errors are available. We first address issues of choosing a sample for a meta-analysis since recent studies report numerous pass-through

[4] In the context of meta-analysis, the terms “fixed-effect” and “random-effects” denote alternative assumptions about the common population or plural populations being sampled when estimates from different empirical studies are combined. We discuss these assumptions in more detail below. The terminology should not be confused with the panel-data estimators with the same name.

estimates (exceeding 40 estimates in each of eight studies). Results are reported for a larger sample of 76 estimates and a smaller sample of 50 “best estimates.” Appendix B (on-line) discusses heterogeneity and provides additional meta-analysis results, including funnel graphs. Section V contains the conclusions. Overall, point estimates suggest that overshifting of alcohol taxes exists for about half of the primary studies, but confidence intervals usually are substantial. Meta-analysis averages indicate that overshifting is more strongly supported for beer compared to spirits, but full-shifting of taxes cannot be rejected based on bias-corrected meta-regressions.

II. IMPERFECT MARKETS AND OVERSHIFTING OF EXCISE TAXES

As is well known, pass-throughs of specific taxes in perfectly competitive markets reflect underlying demand and supply price elasticities. Regardless of statutory liability, excise taxes are shifted forward to final consumers and backwards to factors of production (land, labor, capital, etc.), with a larger portion of a tax borne by the less price-elastic side of the market. A perfectly elastic supply schedule implies a pass-through rate of one for final consumers, also referred to as a fully-shifted tax. More generally, pass-through rates should lie between zero and one and overshifting to final consumers is not expected under competitive market conditions. However, initial or short-run incidence and long-run burden of a tax might differ due to administrative costs of price changes or adjustments in related markets for substitutes and complements.

Most primary studies reviewed below adopt imperfect competition as an explanation for possible overshifting. Several studies also test empirically for effects of local market concentration on observed pass-through rates (Chua, 2000; Parsons, 2007; Shrestha and Markowitz, 2016; Tiwary, 2011). Unfortunately, various theoretical models do not yield uniform predictions regarding tax shifting. As summarized by Fullerton and Metcalf (2002) and Hindriks and Myles (2013), a firm in an imperfect market recognizes that forward-shifting of a tax reduces demand for its product and may react by increasing price more than the tax to offset declines in revenue and profits. The success of this strategy depends generally on the shape of the firm's demand schedule and reactions of rival firms. If the demand schedule is concave to the origin – more elastic as quantity declines – then undershifting is predicted. If the schedule is sufficiently convex (isoelastic) to the origin, then overshifting can occur with the degree of overshifting decreasing as the number of firms rises and increasing as demand becomes less elastic. Either demand is consistent with imperfect competition, so theory does not support a polar outcome. A tax increase also reduces the equilibrium number of firms, so there is a possible secondary effect on market price and tax incidence. Numerous theoretical papers elaborate on these basic insights, with results supporting a broad range of possibilities for tax incidence. Stern (1987) examined tax incidence using models for perfect competition, monopoly, Cournot duopoly, and monopolistic competition. Results indicate that if markets are not competitive, analysis of tax-shifting "should allow for a much broader range of possibilities" (Stern, 1987, p. 154). Further, according to Fullerton and Metcalf (2002, p. 1832), allowing for heterogeneous products results in more avenues for firms to compete on product variety, quality, and non-price competition. These choices also affect the extent to which taxes are shifted-forward to retail prices.[5]

Several recent theoretical papers provide insight into markets for alcohol beverages. Tremblay and Tremblay (2017) argue the U.S. market for beer is characterized by a domestic price leader (Budweiser) and market followers who may choose to compete on price or output. In their model of a Cournot-Bertrand duopoly, one firm maximizes profit with respect to price and

[5] Two papers for beer and wine provide tests of Barzel's (1976) hypothesis that higher excise taxes result in producer substitution toward untaxed dimensions of product quality (Ljunge, 2011; Rojas and Shi, 2011); see also Blecher (2015). Further, Panzone (2012) suggests that wine retailers may overshift taxes as a (faux) quality signal prior to actual price discounting and he provides empirical evidence consistent with this hypothesis.

its rival firm maximizes with respect to output. Tremblay and Tremblay (2017, p. 756) demonstrate that demand convexity affects tax incidence, but more importantly a tax increase will affect firms' prices asymmetrically (citing evidence from the U.S. beer market). If products are differentiated, an output-choosing firm passes on a larger share of a tax increase (citing evidence from the U.S. cigarette market). The authors conclude that tax incidence analysis is complex as pass-through rates can vary across firms in the same industry even if they face similar demand and cost conditions.[6] Two papers by Dutkowsky and Sullivan (2014, 2017) consider tax incidence under monopolistic competition, with emphasis on retail sectors for alcohol. They derive a first-order condition for optimal price that maximizes tax revenues (Dutkowsky and Sullivan, 2014, p. 114). Evidence from two empirical studies of alcohol tax incidence is used to assess observed tax levels, with the conclusion that alcohol beverages are generally undertaxed for tax revenue maximization. Further, if cross-price elasticities are important, higher tax-price ratios are required (Dutkowsky and Sullivan, 2017).

Where overshifting of alcohol taxes is found empirically, models of imperfect markets are often cited for theoretical support. However, several papers suggest alternative theoretical underpinnings. First, vertical market structure may be important, with a likelihood of "double marginalization" of tax hikes due to statutory separation of producers, wholesalers, and retailers of alcohol in the U.S. and other countries (Bako and Berezvai, 2013; Tiwary, 2011; West, 2000). Second, administrative costs of adjusting wholesale and retail prices may be important. Firms do not respond to every minor cost change, so a tax change may be combined with previous

[6] Rojas (2008) studied pricing behavior in the U.S. brewing industry, subject to the 1991 U.S. Federal excise tax hike on beer (a 100% increase from $9 to $18 per barrel). Comparing predicted price increases to actual increases, he rejects both collusion among all brands and collusive price leadership. He finds Stackelberg leadership by Budweiser outperforms other models. Actual price increases are underpredicted in most cases (44 out of 63 brands), but overpredicted more often for the two largest beer producers (Anheuser-Busch and Miller).

uncompensated cost changes, resulting in a single price hike and overshifting in the short run. Two incidence studies reviewed below (Chua, 2000; Conlon and Rao, 2016) test for sticky prices and menu costs as determinants of tax pass-throughs. Other empirical studies include lags (and leads) of taxes to test for price adjustments over time. Third, alcohol taxes and prices can change abruptly at borders and six studies (reviewed below) examine how pass-through rates vary with distance to borders and access to lower-priced substitutes in adjacent states or countries. The picture that emerges is one of considerable complexity in price-adjustments, thus suggesting diverse empirical estimates for alcohol tax pass-through rates.

III. SYSTEMATIC REVIEW OF ALCOHOL TAX PASS-THROUGH RATES

Systematic narrative reviews provide qualitative assessments of a body of literature. This paper combines a narrative review with a quantitative assessment. Because narrative reviews engage in "vote counting" without full regard to precision of estimates, narrative results or conclusions are prone to Type II errors or false negatives (Borenstein et al., 2009). The null hypothesis is an alcohol tax pass-through rate of one. As discussed below, publication bias can distort results in the opposite direction toward false positives. However, meta-analysis of alcohol rates is limited by heterogeneity in primary studies. Lacking a large sample of homogenous estimates, combining a systematic review with a meta-analysis provides a comprehensive literature summary with attention to details of each study, numerical averages, and a final synthesis of qualitative and quantitative results.

A. Literature Search

Estimates of tax pass-throughs are contained in the economics literature dating back to an early contribution by Niskanen (1962) and more recently in public health literatures. A systematic search was conducted, designed to identify scholarly contributions with empirical estimates for pass-through rates including published articles and "grey literature" documents (working papers, dissertations, theses, government and consulting reports). Four main sources were searched: *JSTOR*; *PubMed*; IDEAS/*RePEc*; and *Google Scholar*. Searches were conducted using various combinations of title/abstract/keywords for alcohol/beer/wine/liquor/spirits* AND tax* AND pass-through*, where * is a truncation indicator for all forms of a root word (e.g., tax, taxes, taxation). In addition, searches were conducted using *Dissertation Abstracts*; *Social Science Research Network*; and *Web of Science*. For widely-cited primary studies, such as Kenkel (2005) and Young and Bielinska-Kwapisz (2002), *Google Scholar* was used to detect other sources citing these papers. For recovered studies, duplicates were eliminated and information in the title-abstract was used to narrow the search. Exclusions include studies with combined VAT and excise taxes; undergraduate papers (Fadia, 2006); an article with brief mention of observed pass-through rates (Chetty et al., 2009, p. 1163); and a report where it was not possible to extract comparable estimates (PriceWaterhouseCoopers, 2010).[7] The literature search yielded 29 papers, including 12 journal articles and chapters; 9 working papers; 4 dissertations; and 4 reports. Sixteen studies provide evidence for the U.S. and 13 studies cover other countries. Median year of publication is 2012 and median data year is about 1999. Each study was read several times to recover pertinent details for data, methods, and results.

B. Benchmark Reduced-Form Price Models

Two benchmark econometric models have emerged in this literature, with variation in specifications due to data differences, research objectives, and perhaps institutional details of

[7] During the period 2003-2005, several Nordic countries reduced taxes on alcohol to comply with European Union regulations. Average changes in reported prices tend to suggest pass-through rates of less than one for tax cuts; see Nelson and McNall (2017) for a review of studies for Denmark, Finland, and Sweden.

beverage markets. The models draw on earlier work on incidence of sales taxes by Besley and Rosen (1999) and Poterba (1996). The first model appeals directly to price formation in a competitive market. Aggregating to the beverage level, market demand at time *t* is given by $Q_t = f(P_t, P_t^{subs}, Inc_t, X_t)$ where Q_t represents quantity demanded at time *t*; *P* is the tax-inclusive retail price faced by consumers; P^{subs} are cross-prices of substitutes; *Inc* is consumer income; and *X* represents other variables that shift demand (e.g., demographics). Market supply is given by $P_t = g(MC_t(w_t, K_t), Tax_t, Q_t)$ where *MC* represents marginal cost; *w*'s are prices of variable inputs; *K* is quantity of capital; and *Tax* is a per unit excise tax. Substituting for quantity in the supply equation and including an additive error term yields the following reduced-form price model (Pipoblabanan, 2008):

$$(1) \qquad P_t = \pi_0 + \pi_1 P_t^{subs} + \pi_2 Inc_t + \pi_3 X_t + \pi_4 w_t + \pi_5 K_t + \pi_6 (Tax)_t + e_t$$

where π coefficients are reduced-form parameters; π_6 is net effect of a unit increase in the excise tax (i.e., $\pi_6 > 1$ indicates overshifting); and *e* is an error term. Endogenous quantity and other potentially endogenous variables (e.g., outlet density) do not appear in (1). However, four primary studies include these variables without econometric tests for exogeneity (Chua, 2000; Hunt et al., 2018; Shrestha and Markowitz, 2016; and Siegel et al., 2013).[8] Alternatively, these studies could report results with and without potentially endogenous variables.

Second, many primary studies exploit the panel nature of their data, using either a difference-in-differences model with a specific control group or, more typically, with a panel comprised of U.S. states or other localities. Some studies estimate a panel model in first-difference form; include lagged taxes; or introduce spatial variables to capture cross-border

[8] Alcohol taxes might be endogenous, although infrequency of tax changes and small budget shares due to alcohol rule this out in most cases (Young and Bielinska-Kwapisz, 2002). None of the studies reviewed here provide endogeneity tests. Besley and Rosen (1999) report no changes after controlling for political variables in a price equation for sales taxes; see Fredriksson et al. (2009) and Kubik and Moran (2002) for additional analysis.

shopping. Incorporating some extensions, a panel data version of a reduced-form model is given by (Bergman and Hansen, 2017):

$$(2) \qquad \Delta P_{i,t} = \sum_{k=0}^{4} \beta_k (\Delta Tax)_{i,t-k} + \sum_{j=1}^{N} \gamma_j Z_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}, \; i = 1, \ldots, I$$

where ΔP_t is change in after-tax price between t and t - 1; ΔTax is change in tax lagged over four time periods; Z is a vector of N controls for observable cost and demand variables; α_i is a fixed effect for the *i-th* sample unit (e.g., stores, cities, states); α_t is a common across-market time fixed effects; and ε is an error term. Unobserved demand and cost shocks often are assumed to be captured by fixed effects in (2). The total pass-through is the sum of coefficients on tax variables, including an initial effect given by β_0. Ideally, studies report the initial effect and total effect with associated standard errors (e.g., Bergman and Hansen, 2017). Panel data stationarity tests also should be reported. Equation (2) is easy to implement and data requirements are modest using fixed effects. However, the mark-up on taxes might vary in systematic ways that are missed by fixed effects. As noted by Conlon and Rao (2016), empirical applications do not always make allowance for factors that might affect pass-throughs, such as size of a tax hike, baseline prices, price segment, or type of seller. Some of these complexities are noted below where empirical evidence is available. Conlon and Rao (2016, p. 3) also caution that “price changes are discrete, and that the relationship between price changes and tax changes is likely to be nonlinear.”

C. Narrative Review of Alcohol Excise Tax Pass-Through Studies

Table 1 provides a summary of each primary study organized by beverage. Basic details are provided for coverage by country; data period and type of data; basic results for under- or overshifting of taxes; and numerical values for pass-through rates and standard errors. Based on our reading, reported rates are representative of results in each primary study. A more detailed summary of each study is contained in Appendix A. It should be noted that we do not report all numerical estimates contained in each study. Recent studies subdivide microdata in various informative – but relatively unique – ways that result in myriad estimates. For example, Ally et al. (2014) report 198 pass-through rates covering three beverages; 11 price points; two different regression specifications; and four sensitivity analyses. Shrestha and Markowitz (2016) report 60 estimates for beer. No summary can capture this level of detail and the narrative review and meta-analysis focus on basic results that are comparable across studies. Lastly, pass-through rates are traditionally expressed as ratios in monetary units; i.e., price change in cents for a tax change of one cent per unit. One study (Hunt et al., 2010) expresses rates as a tax elasticity without transformation; their results are reported in Table 1 but excluded from the meta-analysis. Baker and Brechling (1992) and Carbonnier (2013) also estimate tax elasticities but transform results to yield pass-through rates. In a few other cases, transformation of estimates was required using guidance in the primary studies (see Appendices).

1. Price data employed and frequency

Price data are divided into aggregate data (state, country, annual) and microdata (brands, stores, cities). Some datasets represent combinations such as American Chamber of Commerce Researchers Association (ACCRA) quarterly U.S. city-level prices for leading brands, which several studies aggregate to annual or state levels. Several early time-series studies use a single baseline observation for prices and prices indexes for latter periods. A wide variety of data have been employed, including recent use of transaction prices from supermarkets and surveys:

● *Studies using aggregate data for prices.* Ardalan and Kessing (2017) use monthly country-level prices for 28 EUR countries; Baker and Brechling (1992), quarterly UK price indices and annual consumer expenditures; Bako and Berezvai (2013), monthly average HU domestic beer prices; Barzel (1973), brand prices for one year in one US state; Carbonnier (2013), monthly FR price index and baseline prices; Chua (2000), annual ACCRA city prices; Cook (1981), annual US state prices of leading spirits brands; Hunt et al. (2010), annual UK prices; Hunt et al. (2018), annual state ACCRA prices; Loretz and Zwirn (2015), annual EUR country-level prices from a trade source; Niskanen (1962), annual US brand prices; Parsons (2007), monthly JP price index and retail prices of four leading brands; Pipoblabanan (2008), annual US price index and price proxies; Rabinovich et al. (2012), one monthly price and price indexes for four EUR countries from various central sources; Stehr (2007), annual state ACCRA prices; and Young and Bielinska-Kwapisz (2002), quarterly state ACCRA prices.

● *Studies using microdata for prices*. Ally et al. (2014) use weekly UK supermarket prices; Bergman and Hansen (2017), monthly brand-level prices from DK retail outlets; Chua (2000), quarterly city Infoscan prices for US beer brands; Conlon and Rao (2016), monthly Nielsen Homescan prices in two US states; Hanson and Sullivan (2015), Bud Light and Miller Lite retail prices in four US states for 13 weeks; Harding et al. (2010), weekly Nielsen Homescan prices for US consumers; Hindriks and Serse (2018), monthly average of daily scanner prices from a BE supermarket chain for six major spirits brands; Kenkel (2005), before-after monthly survey prices of retail outlets for 14 brands in one US state; Mathes and Carpenter (2015), quarterly ACCRA city prices; Russell and Van Walbeek (2016), monthly SA prices for 23 brands; Shang et al. (2018), city-level OECD prices; Shrestha and Markowitz (2016), quarterly ACCRA city prices; Siegel et al. (2013), on-line US retail prices by brand for four months; and Tiwary (2011), quarterly US city Infoscan brand prices.

2. Regression models: nominal versus real prices and taxes, levels versus differences

Equations (1) and (2) leave unclear whether the price-tax model should be estimated in nominal or real terms or if the regression equation should be estimated in levels or first-differences. Duration of data series and stationarity issues sometimes dictate choices. Two studies (Ally et al., 2014; Shrestha and Markowitz, 2016) compare results for nominal and real prices, with little effect on results. Several studies include a Consumer Price Index (CPI) as a control variable. Numerous studies include time and market fixed effects, which in part capture inflationary trends and cross-sectional differences in cost-of-living. Most studies conducted since 2010 report cluster-robust standard errors (Appendix A). Common features among studies including model specifications and econometric methods are summarized as follows:

● *Studies using nominal prices and taxes.* Ally et al. (2014) use quantile panel regressions in levels including expected price as a regressor; Ardalan and Kessing (2017), panel regression in first-differences including cost controls; Baker and Brechling (1992), OLS regression using log first-differences including cost controls and CPI, allowing for size of tax change; Barzel (1976), OLS regression in levels including wholesale price net of taxes; Bergman and Hansen (2017), panel regression in first-differences including cost controls and CPI; Carbonnier (2013), OLS and SUR regressions in log-levels with cost controls and substitute prices; Chua (2000), panel regression of city-brand price changes with tax changes and indicators of competition; Conlon and Rao (2016), panel regression in first-differences with fixed effects for product, retailer, and time; Cook (1981), median of standardized price change in states with tax hikes; Hanson and Sullivan (2016), brand-level OLS regression including location, store-type, income, and demographics; Harding et al. (2010), OLS regression in levels including location, income, and demographics; Hindriks and Serse (2018), difference-in-differences regression with location, income, cross-border prices, store type, and population density; Hunt et al. (2018), panel regression in levels with checks for autocorrelation; Loretz and Zwirn (2015), panel regression in levels; Siegel et al. (2013), three-level hierarchical model for brands, stores, and states for prices in levels with controls for consumption, outlet density, CPI, and income; Stehr (2007), panel regression in levels with corrections for serial correlation; and Tiwary (2011), mean price change by brand divided by tax change.

● *Studies using real prices and taxes.* Bako and Berezvai (2013) use an OLS regression in first-differences including cost controls and imported beer price; Chua (2000), panel regression in levels for Infoscan brand prices with cost controls, regulations, income, demographics, inflation rate, and city-level CPI; Hunt et al. (2010), OLS regression of log price on log excise duty using aggregate time-series; Hunt et al. (2018), GLS panel regression in levels for prices and taxes with income growth, unemployment, wine prices, and beer consumption; Kenkel (2005), price change divided by tax hike, averaged for each brand and outlet type; Mathes and Carpenter (2015), difference-in-differences regression for prices and taxes with cost controls at city-level; Niskanen (1962), three-stage least-squares regression of price level on tax, quantity, stocks, and time; Parsons (2007), change in price index divided by change in tax rate on beer; Pipoblabanan (2008), IV-FGLS regression of prices on taxes with costs, capital, prices of substitutes, income, demographics, lagged quantity, and time; Rabinovich et al. (2012), panel regression of prices on taxes in levels with once-lagged prices; Russell and Van Walbeek (2016), OLS regression in first-differences with both leads and lags of excise taxes; Shang et al. (2018), difference-in-differences regression of prices in levels, with controls for income and demographics and sensitivity analysis for first-differences and SUR model; Shrestha and Markowitz (2016), difference-in-differences regression of prices in levels, with controls for income, regulations, outlet density, demographics, market concentration, and state-specific trends; and Young and Bielinska-Kwapisz (2002), panel regression of prices and taxes in levels with corrections for serial correlation.

3. *Importance of lagged tax rates*

Several prior studies test if lags of taxes are important for incidence. A consensus has emerged that taxes are generally passed-through within a few months. Primary studies in Table 1 for alcohol excise taxes do not appear to refute this conclusion:

● *Studies that include tax lags (and leads).* Ardalan and Kessing (2017) include one month lag and one month lead, which are not significant with other controls included (tests also for 6-12 months of lags and leads); Bako and Berezvai (2013), test for up to five quarterly lags (none significant); Baker and Brechling (1992), one quarter lag for wine (significant); Bergman and Hansen (2017), four monthly lags (individual significance not reported); Carbonnier (2013), two monthly lags (first lag generally significant); Chua (2000), one year lag for ACCRA prices (not significant) and three quarterly lags for Infoscan brand prices (generally insignificant); Hindriks and Serse (2018), three to five monthly lags (all significant, but most of the shift is in the first month); Russell and Van Walbeek (2016), two monthly leads and two monthly lags (one lead and one lag generally significant; also tests for up to nine lags); Rabinovich et al. (2012), one month lag of tax and price (significance not reported); Shang et al. (2018), two-year lag and lead for taxes (most estimates are insignificant); and Young and Bielinska-Kwapisz (2002), four quarterly lags by beverage (jointly insignificant).

4. *Importance of border effects*

Cross-border purchases of alcohol often figure importantly in debates regarding tax hikes. Six studies examine effects of borders on pass-through rates including attempts to determine width of the border, with an expectation that pass-through rates will be greater as distance increases from lower-tax borders:

● *Studies that examine border effects.* Bergman and Hansen (2017) examine pass-throughs by retailers along the Danish border with Germany and find distance is important for beer, but not spirits. Hanson and Sullivan (2016) include distance of outlets to nearest U.S. state border. At a bandwidth of 10 miles (16km), they find prices are *reduced* on higher tax side of the border. Harding et al. (2010) report strong state border effects for beer (median distance, 107 miles or 172km), including a finding that controlling for border effects increases tax burdens borne by consumers. Hindriks and Serse (2018) compute distance from Belgium retail outlets to borders with France, Germany, Luxembourg, and the Netherlands. Belgium stores greater than 20km (12 miles) from borders do not tend to set lower prices and border effects are significant for only Luxembourg. Loretz and Zwirn (2015) report cross-border shopping in Belgium and Germany due to a 10% spirits tax hike in the Netherlands. Shrestha and Markowitz (2016) estimate panel models with and without state border variables and find little difference in results.

5. *Tests for underlying causes of overshifting and other results with policy significance*

As discussed above, several alternative theories besides imperfect competition have been proposed for overshifting of excise taxes. We briefly review tests of alternative theories and summarize other empirical results of significance for public policy on alcohol taxation. First, four studies attempt to explain variation in pass-through rates by measuring degree of competition in alcohol markets. Chua (2000, p. 118) reports that overshifting for beer taxes is higher in U.S. cities with *lower* seller concentration due to tacit collusion following the 1991 Federal tax hike. Hindriks and Serse (2018) report that a greater number of competing retailers (within a 15-min. drive) reduces pass-throughs for spirits. Shrestha and Markowitz (2016) examine effects of producer concentration and major beer industry mergers, but neither variable is important. Similar negative findings for market concentration are reported in Tiwary (2011). In general, strong evidence is lacking for higher market concentration as a cause of overshifting. Second, two studies argue that overshifting is due to vertical structure of alcohol markets, suggesting that taxes are fully shifted at producer or wholesale levels (Bako and Berezvai, 2013; Tiwary, 2011). Comparisons of license and control ("monopoly") states in the U.S. indicate slightly *lower* pass-throughs for spirits in control states (Young and Bielinska-Kwapisz, 2002), which might reflect "three-tier" systems in license states. Some evidence inconsistent with double marginalization is reported by Barzel (1976, p. 1196), who notes similar pass-throughs at wholesale and retail levels. Third, two studies test for menu costs and nominal price rigidity (*Ss* model) as an explanation for overshifting. Chua (2000, p. 137) rejects the hypothesis based on a comparison of brand prices before and after the 1991 Federal tax hike on beer. A more rigorous set of tests is found in Conlon and Rao (2016), who report that taxes at wholesale for spirits are fully shifted in one month, but retail prices are overshifted reflecting infrequent, discrete price changes. They suggest that even small tax hikes can trigger large retail price changes.

● *Other results with policy significance*. Ally et al. (2014) report that UK taxes on products sold above the median price category are overshifted and cheapest products experience undershifting. Baker and Brechling (1992) test for differences in size of UK tax changes (annual revalorized changes versus larger "unanticipated" changes). They find that smaller changes are overshifted for beer and wine and larger changes are undershifted. Bergman and Hansen (2017) report considerable heterogeneity of pass-throughs among retailers and brands, with pass-throughs from tax hikes considerably greater than those for tax cuts. Additionally, the larger is a tax change, the smaller is the pass-through. Chua (2000, p. 118) finds initial overshifting for low-priced beers, but undershifting after two quarters. However, percentage price increases are slightly higher for low-priced popular brands (14% versus 11-12%). Conlon and Rao (2016) find that pass-through rates are higher for liquor stores with lower prices for given product and rates also are higher for smaller popular-sized products. Hindriks and Serse (2018) report a higher pass-through for a low-priced vodka brand. Harding et al. (2010) report that consumers alter their choices when taxes increase, which for beer means a downgrade in quality. They also report major differences among demographic groups. Kenkel (2005) finds that outlets with higher base prices for a given brand had lower pass-through rates. For individual beer brands, Russell and Van Walbeek (2016) find pass-throughs for larger-size bottles are lower compared to smaller bottles and six-packs (although overshifted). Shang et al. (2018) find no significant differences of shifting rates related to different levels of OECD prices. Tiwary (2011, p. 25) reports slightly higher percentage price changes for US budget beer brands (14% versus 10-13%).

6. Median pass-through rates for beer, wine, and spirits taxes

Twenty-three studies provide estimates of excise tax pass-through rates for beer. Selection of representative numerical values for each study is discussed in the next section and Appendix B. The summary here is based on the narrative review, where a full pass-through is defined as a rate in the range 0.95 to 1.05 (ignoring standard errors). As reported in Table 1, beer taxes are overshifted in 11 of 23 studies; fully shifted in one study; undershifted in six; and five studies report mixed results. The range of positive estimates for beer is substantial: 0.56 to 3.84, with a median rate of 1.28 for 50 estimates. Only ten studies estimate pass-through rates for excise taxes on wine. Six studies support overshifting; three studies support undershifting; and one reports mixed results. The range is 0.09 to 4.19, with a median of 1.34 for 16 rates. Eighteen studies estimate pass-through rates for spirits. Only five studies support overshifting; one study supports full shifting; six studies indicate undershifting; and mixed results are found in six studies. The range is 0.70 to 3.28, with a median of 1.08 for 38 estimates. Combining estimates for wine and spirits yields a median rate of 1.11 for 54 estimates.

7*. Stylized facts from a systematic review of alcohol tax pass-through rates.*

As discussed above, analysis of pass-through rates is complex, reflecting differences in beverages, brands, producers, retailers, base prices, timing of price adjustments, size of tax change, competition, and border effects. In the long-run, additional market adjustments are possible, such as changes in product variety or number of retailers. In general, results in Table 1 indicate a high degree of complexity in alcohol markets. Overshifting is indicated most strongly for beer taxes and least strongly for spirits taxes. Wine taxes might be overshifted, but a smaller number of studies limits confidence in this outcome. Several other stylized facts emerge from the review where evidence seems sufficiently strong. First, use of nominal prices and taxes in econometric models does not seem to matter as many studies include time fixed effects, CPI variables or unit-specific time trends. Second, taxes are passed-through quickly and long-term effects usually occur within a few months. Third, border effects are important, but complicated by the possibility that prices might change on both sides of a border following a tax hike, thus contaminating a natural experiment. Fourth, underlying causes of overshifting remain in doubt, but attempts to link local market concentration to pass-through rates have been unsuccessful. Fifth, conflicting evidence exists on pass-throughs by price level, with only one UK study reporting undershifting for cheaper brands (Ally et al., 2014) and six other studies suggesting overshifting or higher percentage price hikes for lower-priced brands. Sixth, while there is substantial diversity in data and methods used to measure incidence, only six estimates in Table 1 are not statistically different from zero. Seventh, 22 of 51 entries suggest alcohol taxes are overshifted, close to a 50%-50% outcome that frequently occurs in qualitative reviews. Eighth, all median values indicate some degree of overshifting. However, estimates in Table 1 are not of equal quality or precision. Meta-analysis samples used in the next section exclude estimates with missing standard errors; negative estimates; a few estimates where data are of questionable quality; and estimates that explore relatively unique aspects of a given data set. The meta-analysis tests statistically if average rates are significantly greater than one for each beverage after controlling for precision of estimates and publication bias.

IV. META-ANALYSIS OF ALCOHOL TAX PASS-THROUGH RATES

Meta-analysis is the quantitative synthesis of primary studies containing estimates of similar empirical results or effect sizes. Statistical methods are used to combine, analyze, and synthesize results from multiple, related studies with the objective of drawing general conclusions about average magnitudes and sources of variation in effects. Compared to narrative summaries, meta-analysis increases statistical power and accuracy of estimation, and provides more rigorous tests of basic hypotheses such as overshifting. Formal use of meta-analysis in economics can be traced to 1989-90, although an early contribution by Saxonhouse (1976) qualifies as the first meta-analysis applied to economic data. Basic introductions to meta-analysis include Borenstein et al. (2009, 2010, 2015b); Card (2012); Nelson (2015b); Ringquist and Anderson (2013); and Stanley and Doucouliagos (2012). Two alternative statistical models are used to summarize results, expressed either as weighted averages or as predictions from a meta-regression. In the common or *fixed effect-size* (FES) *model*, there are *n* primary studies and the sample of estimates are assumed to a share a singular population effect. Primary estimates are viewed as independent draws from the population with a sampling or measurement error. An estimate of the true population effect is a precision-weighted sample mean, where weights are inverse variances of primary estimates. Estimates with smaller variances are given more weight because they are assumed to contain more precise information. Economic theory applied to competitive markets suggests a FES model with a population pass-through of unity, but there are reasons to believe the true effect varies from study to study. For example, pass-through rates for beer might be fundamentally different from wine and spirits because suppliers, consumers, regulations, and markets differ. As a result, all primary studies in Table 1 report beverage-specific rates. Population rates also might vary by time or country due, for example, to global industry consolidation, convergence of alcohol consumption patterns, and fundamental differences in markets across countries (Bentzen and Smith, 2018; Lockwood and Migali, 2009; Madsen et al., 2012; Miller and Weinberg, 2017; Mills, 2018). In the plural or *random effects-size* (RES) *model*, the true effect varies *a priori* from study to study. Average estimates are based on weights that combine primary study variances and an estimate of the between-study variance, where the latter variance is the same for all estimates. The resulting average is an estimate of the mean of a hyper-distribution of true effects (Borenstein et al., 2010). Compared to the FES model, RES-averages give greater weight to less precise estimates and the weighting also reduces the influence of outliers on effect sizes and standard errors (Nelson, 2013, 2015b).

Finally, heterogeneity in effect sizes might arise due to publication bias if primary researchers selectively report results based on standard errors of effects or statistical significance.

Formally, there are *n* estimates of the population effect that are assumed to be independent of each other. The true common effect-size is given by β and the estimate reported in the *i-th* study is denoted by Y_i, with a standard error s_i. The FES model assumes that observed estimates are generated by $Y_i = \beta + e_i$, where e_i is a sampling error with mean zero and variance σ^2. Fixed-effect weights are defined as $w_i = 1/s_i^2$. The estimate of the common population mean is given by (3), which is the sum of products divided by the sum of weights:

(3) $\bar{\beta} = \sum w_i Y_i / \sum w_i \ , \ i = 1, \ldots, n$

Alternatively, the RES model assumes each estimate is a random draw from a distribution of true effects. Heterogeneity among underlying populations is modeled by $Y_i = \beta_0 + u_i$, where u_i is an error term with mean zero and variance τ^2. Random-effects assume that observed estimates are generated by $Y_i = \beta_0 + u_i + e_i$, where errors are assumed to be independent. The estimated variance of each primary effect is given by a composite error term, $V_i^2 = s_i^2 + T^2$, where T^2 is an estimate of variation in true effect sizes across populations. There are several methods for obtaining estimates of T^2, with method-of-moments used in the present study. The RES-average is given by (4), with mean of a universe of populations denoted by $\bar{\beta}_0$ and weights $w_i^* = 1/V_i^2$:

(4) $\bar{\beta}_0 = \sum w_i^* Y_i / \sum w_i^* , \ i = 1, \ldots, n$

A. Subsamples of Estimates for Meta-Analysis

As documented above, studies of tax pass-throughs contain numerous estimates obtained using diverse data and methods. The twenty-nine primary studies contain 912 total estimates, including 457 beer rates, 113 wine rates, and 342 spirits rates (Appendix B). Eight studies produce more than 40 estimates each and two report more than 90 estimates each (Ally et al., 2014; Hanson and Sullivan, 2016). Meta-analysis offers little guidance about which studies and estimates are comparable or independent, and a common criticism is that meta-analyses often combine "apples and oranges" (Borenstein et al., 2009; Nelson and Kennedy, 2009; Rhodes, 2012; Smith and Pattanayak, 2002). We seek to avoid this problem through use of two samples of estimates. The first sample contains 76 estimates. We use most values reported in Table 1, excluding those with missing standard errors and estimates that can only be described as unique (e.g., negative rates).[9] The second sample of 50 effects is a set of "best estimates," which narrows criteria for inclusion. We use values that best convey the broad effects of taxes on each beverage and ignore estimates based, for example, on narrowly-defined price segments or border areas. Further, we attempt to select values which represent independent estimates; e.g., estimates for state taxes versus federal taxes, but not multiple estimates for state taxes in the same study. The selection process is described more fully in Appendix B and best estimates for each primary study are reported in Tables 2 and 3.

B. Precision Weighted-Means by Beverage

Following standard practice in meta-analysis, three subgroups of estimates are defined: beer, wine, and spirits. Homogeneity tests using Q-statistics confirm that subgroup analysis is appropriate (Appendix B). Analysis is carried out for each beverage individually and a combination of wine and spirits effects. Selective results also are reported for all alcohol beverages. Table 2 displays estimates for weighted-means for beer. In the larger sample for beer, weighted-means for 40 estimates are 1.14 for the FES model and 1.40 for the RES model. Both

[9] Lipsey and Wilson (2001, p. 107) warn the following about the risks of outliers in meta-analysis: "The purpose of a meta-analysis is to arrive at a reasonable summary of the quantitative findings of a body of research studies. This purpose is not served well by the inclusion of extreme effect size values that are notably discrepant from the preponderance of those found in the research of interest and hence, unrepresentative of the results of that research and possibly even spurious. In addition, extreme effect size values have disproportionate influence on the values of means, variances, and other statistics used in meta-analysis and may distort them in misleading ways."

averages are significantly greater than unity using a 95% confidence interval, indicating overshifting of beer taxes. The sample of 24 best estimates yields slightly smaller averages of 1.10 and 1.28. In Table 3, FES and RES-averages are 1.00 and 1.21 for wine and 1.04 and 1.05 for spirits. Due to a small sample, wine rates also are pooled with spirits. Weighted-means for samples of 26 and 36 estimates in Table 3 are all close to 1.0, suggesting full pass-through of excise taxes. Averages for all beverages (not shown) are 1.04 and 1.16 for FES and RES. Hence, initial results indicate overshifting of beer taxes and full-shifting of spirits taxes. Pass-through of wine taxes are uncertain due to a small sample of estimates.

C. Meta-Regressions Corrected for Publication Bias

In the absence of publication bias, effect sizes and standard errors are independent. Observed effects should vary randomly about the true effect. However, if model specifications are selected based on significance of main covariates, estimated effects will tend to vary directly with standard errors; i.e., larger estimated pass-throughs rates will have smaller t-statistics. In the presence of publication bias, reported estimates will be biased in the positive direction and overshifting on average will tend to be the outcome of both narrative reviews and quantitative summaries. That is, publication bias will result in larger (but less precise) effect estimates and results or conclusions in summary analyses are biased toward false positives, meaning average pass-through rates greater than unity. It is straight-forward to correct for publication bias by regressing the effect size on its standard error using an Egger regression or funnel-asymmetry test (Borenstein et al., 2009; Stanley and Doucouliagos, 2012). Intercept coefficients reveal the bias-corrected averages. Table 4 displays meta-regression results, while Appendix B reports funnel graphs.[10] In five of six cases, precision coefficients are significantly positive and greater

[10] Funnel graphs are plots of effect-sizes and standard errors. In the absence of publication bias, plotted values should be symmetric about the mean effect size, resembling a funnel. In the presence of bias, the plot is asymmetric.

than unity, indicating publication bias. Beer coefficients are substantial. To test for overshifting, 95% confidence intervals for bias-corrected intercepts are reported in the last row of Table 4 and the results indicate that full pass-through of alcohol excise taxes cannot be rejected. Results in Table 4 thus indicate that correction for publication bias is important for final conclusions regarding overshifting. Further, Appendix B demonstrates that the results are robust to moderating corrections for country-of-origin, type of data, spirits-only models, precision non-linearity or estimation method for random-effects.

V. CONCLUSIONS AND LIMITATIONS

Alcohol excise taxes tend to be fully shifted, but complexity of markets can lead to different pass-through rates depending on market conditions, product heterogeneity, price level, retailer location, timing, and other factors such as inter-jurisdictional competition (Cook and Moore, 1993; Conlon and Rao, 2016; Nelson, 2002; Bielinska-Kwapisz, 2009). Under these circumstances, design of optimal alcohol taxes is more complicated than suggested by a simple Pigouvian model or reflected in current optimal tax estimates for alcohol. For example, cross-border shopping to avoid taxes involves real resource costs, which need to be counted in analyses of externality-correcting taxes (Christiansen and Smith, 2012). Tax losses for a given jurisdiction of course are counted as transfers at the national level. Alcohol taxes are usually constrained to be uniform within beverage categories, but differences in price-responsiveness of consumers and possible differences in pass-through rates across markets complicate the design and application of externality-correcting alcohol taxes as a public health policy.

This paper is the first to survey and evaluate the substantial range of estimates for excise tax pass-through rates for alcohol beverages. Existing primary studies cover different countries and time periods and use vastly different data and econometric methods. The outcome is considerable heterogeneity of estimates, which is complicated further by reporting of multiple estimates in many studies. With a few exceptions involving ACCRA prices for the U.S., there is little in the way of replication of data and methods. Qualitative and quantitative reviews of 29 studies arrive at several conclusions for fiscal and public health policies: (1) overshifting on average is indicated more strongly for beer taxes and least strongly for spirits taxes; (2) pass-through rates for wine remain in question due to a small sample of studies; (3) meta-regressions indicate that full-shifting of taxes cannot be rejected for any beverage, including beer; (4) taxes are passed-through quickly and long-term effects usually occur within a few months; and (5) border effects are important for price differences, but specific studies are required to pinpoint the magnitude and location of border-effects. Our results also are useful for future empirical research on excise tax pass-through rates. We have summarized alternative theories and empirical models of tax incidence. We have noted some of the empirical difficulties associated with existing studies. For example, very few of the studies provide rigorous tests of stationarity or endogeneity.

Overall, meta-analytic results in the paper are limited by small samples, significant heterogeneity, and outlier values. Only broad across-country comparisons are possible with available data, but reported results are not sensitive to country-origin. Non-linearity remains an issue, but results corrected for publication bias are not sensitive to addition of a quadratic term for precision. Measurement issues associated with prices and other variables, such as cost data, are given attention in a few studies, but for the most part researchers are forced to rely on singular data sets. The infrequency of nominal tax changes implies that variation in basic data is likely to be limited. There also has been relatively little in the way of replication of prior empirical models, but this problem is not unique to the alcohol literature. The difficulties of data combined with diverse econometric models has resulted in a substantial range of estimates. As demonstrated, publication bias also is potentially an important issue, especially for beer tax estimates. In these circumstances, combining a qualitative assessment with a quantitative analysis provides the most useful and comprehensive summary of existing estimates from the literature.

REFERENCES

Ally, Abdallah K., Yang Meng, Ratula Chakraborty, Paul W. Dobson, et al., 2014. "Alcohol Tax Pass-Through Across the Product and Price Range: Do Retailers Treat Cheap Alcohol Differently?" *Addiction* 109 (12), 1994-2002.

An, Ruopeng and Roland Sturm, 2011. "Does the Response to Alcohol Taxes Differ Across Racial/Ethnic Groups? Some Evidence from the 1984-2009 Behavioral Risk Factor Surveillance System." *Journal of Mental Health Policy and Economics* 14 (1), 13-23.

Anderson, Kym, 2010. "Excise and Import Taxes on Wine vs. Beer and Spirits: An International Comparison." *Economic Papers* 29 (2), 215-228.

Anderson, Kym, 2014. "Excise Taxes on Wines, Beers and Spirits: An Updated International Comparison." *Wine & Viticulture Journal* 29 (6), 66-71.

Ardalan, Aria and Sebastian G. Kessing, 2017. "Tax Pass-Through in the European Beer Market." Paper No. 47-2017. Philipps University of Marburg, Marburg, DE. Available at: https://www.econstor.eu/bitstream/10419/174343/1/47-2017_ardalan.pdf

Aronsson, Thomas and Tomas Sjogren, 2010. "An Optimal-Tax Approach to Alcohol Policy." *FinanzArchiv/Public Finance Analysis* 66 (2), 153-169.

Ayyagari, Padmaja, Partha Deb, Jason Fletcher, William Gallo, et al., 2013. "Understanding Heterogeneity in Price Elasticities in the Demand for Alcohol for Older Individuals." *Health Economics* 22 (1), 89-105.

Babor, Thomas, Raul Caetano, Sally Casswell, Griffith Edwards, et al., 2010. *Alcohol: No Ordinary Commodity – Research and Public Policy*, 2nd ed. Oxford University Press, Oxford, UK.

Baker, Paul and Vanessa Brechling, 1992. "The Impact of Excise Duty Changes on Retail Prices in the UK." *Fiscal Studies* 13 (2), 48-65.

Bako, Barna and Zombar Berezvai, 2013. "Excise Tax Overshifting in the Hungarian Beer Market." Discussion Paper. Corvinus University of Budapest, Budapest, HU. Available at: http://unipub.lib.uni-corvinus.hu/1263/1/tax_overflow.pdf

Barzel, Yoram, 1976. "An Alternative Approach to the Analysis of Taxation." *Journal of Political Economy* 84 (6), 1177-1197.

Bentzen, Jan and Valdemar Smith, 2018. "Structural Change in the Consumption of Beer, Wine and Spirits in OECD Countries from 1961 to 2014." *Beverages* 4 (1), article 8.

Bergman, U. Michael and Niels L. Hansen, 2017. "Are Excise Taxes on Beverages Fully Passed Through to Prices? The Danish Experience." Discussion Paper. University of Copenhagen, Copenhagen, DK. Available at: http://web.econ.ku.dk/okombe/BergmanHansen.pdf

Besley, Timothy J. and Harvey S. Rosen, 1999. "Sales Taxes and Prices: An Empirical Analysis." *National Tax Journal* 52 (2), 157-178.

Bielinska-Kwapisz, Agnieszka, 2009. "What Determines Excise Tax Rates?" *Journal of Public Finance and Public Choice* 27 (1), 63-85.

Blecher, Evan, 2015. Taxes on tobacco, alcohol and sugar sweetened beverages: Linkages and lessons learned. *Social Science & Medicine* 136-137 (1), 175-179.

Borenstein, Michael, Larry V. Hedges, Julian P.T. Higgins, and Hannah R. Rothstein, 2009. *Introduction to Meta-Analysis*. Wiley, Chichester, UK.

Borenstein, Michael, Larry V. Hedges, Julian P.T. Higgins, and Hannah R. Rothstein, 2010. "A Basic Introduction to Fixed-Effect and Random-Effects Models of Meta-Analysis." *Research Synthesis Methods* 1 (2), 97-111.

Borenstein, Michael, Larry Hedges, Julian Higgins, and Hannah Rothstein, 2015a. *Comprehensive Meta Analysis Version 3*. Biostat, Englewood, NJ.

Borenstein, Michael, Larry Hedges, Julian Higgins, and Hannah Rothstein, 2015b. *Regression in Meta-Analysis*. Biostat, Englewood, NJ.

Carbonnier, Clement, 2013. "Pass-Through of Per Unit and Ad Valorem Consumption Taxes: Evidence from Alcoholic Beverages in France." *B.E. Journal of Economic Analysis and Policy* 13 (23), 837-863.

Card, Noel A., 2012. *Applied Meta-Analysis for Social Science Research*. Guilford Press, New York.

Chetty, Raj, Adam Looney, and Kory Kroft, 2009. "Salience and Taxation: Theory and Evidence." *American Economic Review* 99 (4), 1145-1177.

Christiansen, Vidar and Stephen Smith, 2012. "Externality-Correcting Taxes and Regulation." *Scandinavian Journal of Economics* 114 (2), 358-383.

Chua, Johanna D., 2000. *Essays in Public Economics*. Ph.D. dissertation. Harvard University, Cambridge, MA. Available at: http://www.worldcat.org/title/essays-in-public-economics/oclc/77070465

Clarke, Harry, 2008. "The Economist's Way of Thinking About Alcohol Policy." *Agenda* 15 (2), 27-42.

Cnossen, Sijbren, 2008. "Do Drinkers Pay Their Way in the European Union?" *FinanzArchiv/Public Finance Analysis* 64 (4), 508-539.

Conlon Christopher T. and Nirupama S. Rao, 2016. "Discrete Prices and the Incidence and Efficiency of Excise Taxes." Discussion Paper. New York University, New York. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2813016

Cook, Philip J., 1981. "The Effect of Liquor Taxes on Drinking, Cirrhosis, and Auto Accidents." In Moore, Mark H. and Dean R. Gerstein (eds.), *Alcohol and Public Policy: Beyond the Shadow of Prohibition*, 255-285. National Academy Press, Washington, DC.

Cook, Philip J., 2007. *Paying the Tab: The Costs and Benefits of Alcohol Control.* Princeton University Press, Princeton, NJ.

Cook, Philip J. and Michael J. Moore, 1993. "Taxation of Alcoholic Beverages." In Hilton, Michael E. and Gregory Bloss (eds.), *Economics and the Prevention of Alcohol-Related Problems*, Research Monograph No. 25, 33-58. National Institute of Alcohol Abuse and Alcoholism, Washington, DC.

Cook, Philip J. and Michael J. Moore, 1994. "This Tax's for You: The Case for Higher Beer Taxes." *National Tax Journal* 47 (3), 559-573.

Dutkowsky, Donald H. and Ryan S. Sullivan, 2014. "Excise Taxes, Consumer Demand, Over-Shifting, and Tax Revenue." *Public Budgeting and Finance* 34 (3), 111-125.

Dutkowsky, Donald H. and Ryan S. Sullivan, 2017. "Excise Taxes, Over-Shifting, Cross-Elasticity, and Tax Revenue." *Applied Economics Letters* 24 (2), 113-116.

Fadia, Ankur S., 2006. "Federal Excise Taxes and the U.S. Beer Industry's Three-Tier System of Distribution: Do Beer Manufacturers Benefit from Federal Excise Taxes?" Honors Thesis. Duke University, Durham, NC. Available at: https://sites.duke.edu/djepapers/2006/08/

Fogarty, James and Giri Parameswaran, 2017. "Alcohol Sin Taxes." Working Paper 1704. University of Western Australia, Crawley, AU. Available at: https://ageconsearch.umn.edu/record/257211

Fredriksson, Per G., Stephan Gohmann, and Khawaja Mamun, 2009. "Taxing Under the Influence? Corruption and U.S. State Beer Taxes." *Public Finance Review* 37 (3), 339-365.

Fullerton, Don and Gilbert E. Metcalf, 2002. "Tax Incidence." In Alan J. Auerbach and Martin Feldstein (eds.), *Handbook of Public Finance*, Vol. 4, 1787-1872. Elsevier, Amsterdam, NL.

Griffith, Rachel, Martin O'Connell, and Kate Smith, 2017. "Design of Optimal Corrective Taxes in the Alcohol Market." IFS Paper W17/02. Institute for Fiscal Studies, London, UK. Available at: https://www.ifs.org.uk/uploads/publications/wps/WP201702.pdf

Hanson, Andrew and Ryan Sullivan, 2016. "Incidence and Salience of Alcohol Taxes: Do Consumers Overreact?" *Public Finance Review* 44 (3), 344-369.

Harding, Matthew, Ephraim Leibtag, and Michael Lovenheim, 2010. "The Heterogeneous Geographic and Socioeconomic Incidence of Cigarette and Beer Taxes: Evidence from Nielsen Homescan Data." Discussion Paper. Cornell University, Ithaca, NY. Available at: http://www.cemmap.ac.uk/forms/scanner_data/sd10_harding.pdf

Heien, Dale M., 1995/96. "Are Higher Alcohol Taxes Justified?" *Cato Journal* 15 (2-3), 243-257.

Herrnstadt, Evan, Ian Parry, and Juha Siikamaki, 2015. "Do Alcohol Taxes in Europe and the US Rightly Correct for Externalities?" *International Tax and Public Finance* 22 (1), 73-101.

Hindriks, Jean and Gareth D. Myles, 2013. *Intermediate Public Economics*, 2nd ed. MIT Press, Cambridge, MA.

Hindriks, Jean and Valerio Serse, 2018. "Heterogeneity in the Tax Pass-Through to Spirits Retail Prices: Evidence from Belgium." Paper 2018/04. Center for Operations Research and Econometrics, Catholic University of Louvain, Louvain, BE. At: https://dial.uclouvain.be/pr/boreal/object/boreal:195857

Hines, James R., 2007. “Taxing Consumption and Other Sins.” *Journal of Economic Perspectives* 21 (1), 49-68.

Hunt, Priscillia, Lila Rabinovich, and Ben Baumberg, 2010. “Preliminary Assessment of the Economic Impacts of Alcohol Pricing Policy Options in the UK.” Rand Europe Report to the Home Office TR-858-HO. Rand Europe, Brussels, BE. Available at: https://www.rand.org

Hunt, Priscillia, Rosanna Smart, and Rosalie L. Pacula, 2018. “Are Alcohol Taxes Still an Effective Policy Lever for Raising Alcohol Prices to Improve Health? Evidence from the Great Recession.” Discussion Paper. RAND Corp., Santa Monica, CA.

Kenkel, Donald S., 1996. “New Estimates of the Optimal Tax on Alcohol.” *Economic Inquiry* 34 (2), 296-319.

Kenkel, Donald S., 2005. “Are Alcohol Tax Hikes Fully Passed Through to Prices? Evidence from Alaska.” *American Economic Review* 95 (2), 273-277.

Kenkel, Donald S. and Willard Manning, 1996. “Perspectives on Alcohol Taxation.” *Alcohol Health & Research World* 20 (4), 230-238.

Kerr, William C., Deidre Patterson, Thomas K. Greenfield, Alison S. Jones, et al., 2013. “U.S. Alcohol Affordability and Real Tax Rates, 1950-2011.” *American Journal of Preventive Medicine* 44 (5), 459-464.

Kubik, Jeffrey D. and John R. Moran, 2002. “Can Policy Changes be Treated as Natural Experiments? Evidence from State Excise Taxes.” Paper No. 39. Syracuse University, Syracuse, NY. Available at: https://surface.syr.edu/cgi/viewcontent.cgi?article=1117&context=cpr

Lipsey, Mark S. and David B. Wilson, 2001. *Practical Meta-Analysis*. SAGE Publications, Thousand Oaks, CA.

Ljunge, Martin, 2011. “Do Taxes Produce Better Wine?” J*ournal of Agricultural & Food Industrial Organization* 9 (1), article 12.

Lockwood, Ben and Giuseppe Migali, 2009. “Did the Single Market Cause Competition in Excise Taxes? Evidence from EU Countries.” *The Economic Journal* 119 (536), 406-429.

LoPiccalo, Katherine, 2016. “Driving to Drink: Tax Avoidance Along the Washington-Oregon Border.” Paper No. 735. Economics Department. University of California, Santa Cruz, CA. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2766043

Loretz, Simon and Gregor Zwirn, 2015. “Taxation of Alcoholic Beverages: Estimation of Tax Revenue Effects in the Netherlands and Europe.” Research Report. Institute for Advanced Studies, Vienna, AT. Available at: http://irihs.ihs.ac.at/3604/

Lowry, Sean, 2014. *Alcohol Excise Taxes: Current Law and Economic Analysis*. CRS Report. Congressional Research Service, Washington, DC.

Madsen, Eric S., Kurt Pedersen, and Lars Lund-Thomsen, 2012. “Effects of the M&A Wave in the Global Brewing Industry 2000-2010.” *German Journal of Agricultural Economics* 61 (4), 235-243.

Marron, Donald B., 2015. “Should We Tax Internalities Like Externalities?” Working Paper. Tax Policy Center, Washington, DC. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2688672

Mathes, Michael T. and Christopher S. Carpenter, 2015. “New Evidence on Beer Prices and Beer Taxes.” In Mathes, Michael T., *Essays on Health Economics: Effect of Economic Forces on Drinking and Smoking-Related Outcomes*, 64-82. Ph.D. dissertation. Vanderbilt University, Nashville, TN. Available at: https://search.proquest.com/docview/1724663795

Miller, Nathan H. and Matthew C. Weinberg, 2017. “Understanding the Price Effects of the MillerCoors Joint Venture.” *Econometrica* 85 (6), 1763-1791.

Mills, Terence C., 2018. “Is There Convergence in National Alcohol Consumption Patterns? Evidence from a Compositional Time Series Approach.” *Journal of Wine Economics* 13 (1), 92-98.

Naimi, Timothy S., Jason G. Blanchette, Ziming Xuan, and Francis J. Chaloupka, 2018. “Erosion of State Alcohol Excise Taxes in the United States.” *Journal of Studies on Alcohol and Drugs* 79 (1), 43-48.

National Research Council, 2004. R*educing Underage Drinking – A Collective Responsibility*. National Academies Press, Washington, DC.

Nelson, Jon P., 2013. “Meta-Analysis of Alcohol Price and Income Elasticities – with Corrections for Publication Bias.” *Health Economics Review* 3 (1), article 17.

Nelson, Jon P., 2014. “Alcohol Affordability and Alcohol Demand: Cross-Country Trends and Panel Data Estimates, 1975 to 2008.” *Alcohol: Clinical and Experimental Research* 38 (4), 1167-1175.

Nelson, Jon P., 2015a. “Binge Drinking and Alcohol Prices: A Systematic Review of Age-Related Results from Econometric Studies, Natural Experiments and Field Studies.” *Health Economics Review* 5 (1), article 6.

Nelson, Jon P., 2015b. “Meta-analysis: Statistical Methods.” In Johnson, Robert J., John Rolfe, Randall S. Rosenberger, and Roy Brouwer (eds.). *Benefit Transfer of Environmental and Resource Values: A Guide for Researchers and Practitioners*, 329-356. Springer, Dordrecht, NE.

Nelson, Jon P. and Peter E. Kennedy, 2009. “The Use (and Abuse) of Meta-Analysis in Environmental and Natural Resource Economics: An Assessment.” *Environmental & Resource Economics* 42 (3), 345-377.

Nelson, Jon P. and Amy D. McNall, 2017. “What Happens to Drinking When Alcohol Policy Changes? A Review of Five Natural Experiments for Alcohol Taxes, Prices, and Availability.” *European Journal of Health Economics* 18 (4), 417-434.

Nelson, Michael A., 2002. “Using Excise Taxes to Finance State Government: Do Neighboring State Taxation Policy and Cross-Border Markets Matter?” *Journal of Regional Science* 42 (4), 731-752.

Niskanen, William A., 1962. “The Demand for Alcoholic Beverages: An Experiment in Econometric Method.” Rand Report P-2583. Rand Corporation, Santa Monica, CA. Available at: https://www.rand.org/content/dam/rand/pubs/papers/2008/P2583.pdf

O’Donoghue, Ted and Matthew Rabin, 2006. “Optimal Sin Taxes.” *Journal of Public Economics* 90 (10-11), 1825-1849.

Panzone, Luca A., 2012. "Alcohol Tax, Price-Quality Proxy and Discounting: A Reason Why Alcohol Taxes May Rebound." *Journal of Agricultural Economics* 63 (3), 715-736.

Parsons, Craig, 2007. "Towards an Empirical Industrial Organization Analysis (New and Old) of the Japanese Beer Industry." Paper CITS WP 2007-01. Yokohama National University, Yokohama, JP. At: http://www.econ.ynu.ac.jp/cits/publications/pdf/CITSWP2007-01.pdf

Perez, Arturo, 2008. *Earmarking State Taxes*. NCSL Fiscal Affairs Program. National Conference of State Legislatures, Washington, DC. Available at: http://www.ncsl.org/documents/fiscal/earmarking-state-taxes.pdf

Pipoblabanan, Chayun, 2008. *Essays on Parametric and Nonparametric Estimation of Market Structure and Tax Incidence in the U.S. Brewing Industry*. Ph.D. dissertation. Oregon State University, Corvallis, OR. At: https://ir.library.oregonstate.edu/concern/graduate_thesis_or_dissertations/x059cb29m

Pogue, Thomas, 2005. "Alcoholic Beverage Taxes, Federal." In Cordes, Joseph J., Robert D. Ebel, and Jane G. Gravelle (eds.), *The Encyclopedia of Taxation & Tax Policy,* 2nd ed., 5-6. The Urban Institute Press, Washington, DC.

Pogue, Thomas F. and Larry G. Sgontz, 1989. "Taxing to Control Social Costs: The Case of Alcohol." *American Economic Review* 79 (1), 235-243.

Poterba, James M., 1996. "Retail Price Reactions to Changes in State and Local Sales Taxes." *National Tax Journal* 49 (2), 165-176.

PriceWaterhouseCoopers, 2010. "Taxing the Brewing Sector: A European Analysis of the Costs of Producing Beer and the Impact of Excise Duties." Report for The Brewers of Europe. PwC Advisory, Madrid, ES. Available at: https://brewersofeurope.org

Public Health England, 2016. *The Public Health Burden of Alcohol and the Effectiveness and Cost-Effectiveness of Alcohol Control Policies: An Evidence Review.* PHE, London, UK.

Rabinovich, Lila, Priscillia Hunt, Laura Staetsky, Simo Goshev, et al., 2012. "Further Study on the Affordability of Alcoholic Beverages in the EU: A Focus on Excise Duty Pass-Through, On- and Off-trade Sales, Price Promotions and Statutory Regulations." Report for the European Commission. RAND Europe, Cambridge, UK. Available at: https://www.rand.org/pubs/technical_reports/TR1203.html

Rhodes, William, 2012. "Meta-Analysis: An Introduction Using Regression Methods." *Evaluation Review* 36 (1), 24-71.

Ringquist, Evan J. and Mary R. Anderson (eds.), 2013. *Meta-Analysis for Public Management and Policy*. Jossey-Bass, San Francisco.

Rojas, Christian, 2008. "Price Competition in U.S. Brewing." *Journal of Industrial Economics* 56 (1), 1-31.

Rojas, Christian and Tianji Shi, 2011. "Tax Incidence When Quality Matters: Evidence from the Beer Market." *Journal of Agricultural & Food Industrial Organization* 9 (1), article 10.

Russell, Caitlan and Corne Van Walbeek, 2016. "How Does a Change in the Excise Tax on Beer Impact Beer Retail Prices in South Africa." *South African Journal of Economics* 84 (4), 555-573.

Saxonhouse, Gary R., 1976. “Estimated Parameters as Dependent Variables.” *American Economic Review* 66 (1), 178-183.

Shang, Ce, Anh Ngo, and Frank J. Chaloupka, 2018. “The Pass-Through of Alcohol Taxes to Prices in OECD Countries.” Discussion Paper. University of Oklahoma, Norman, OK. Available at: https://scholar.google.com/citations?user=h-HPyFgAAAAJ&hl=en&oi=sra

Shrestha, Vinish, 2016. “How Efficient are the Current U.S. Beer Taxes?” *Economics and Political Economy* 3 (3), 446-470.

Shrestha, Vinish and Sara Markowitz, 2016. “The Pass-Through of Beer Taxes to Prices: Evidence from State and Federal Tax Changes.” *Economic Inquiry* 54 (4), 1946-1962.

Siegel, Michael, Jody Grundman, William DeJong, Timothy S. Naimi, et al., 2013. “State-specific Liquor Excise Taxes and Retail Prices in Eight U.S. States, 2012.” *Substance Abuse* 34 (4), 415-421.

Smith, V. Kerry and Subhrendu K. Pattanayak, 2002. “Is Meta-Analysis a Noah’s Ark for Non-Market Valuation?” *Environmental & Resource Economics* 22 (1-2), 271-296.

Stanley. T.D and Hristos Doucouliagos, 2012. *Meta-Regression Analysis in Economics and Business*. Routledge, London.

Stehr, Mark, 2007. “The Effect of Sunday Sales Bans and Excise Taxes on Drinking and Cross-border Shopping for Alcoholic Beverages.” *National Tax Journal* 60 (1), 85-105.

Stern, Nicholas, 1987. “The Effects of Taxation, Price Control and Government Contracts in Oligopoly and Monopolistic Competition.” *Journal of Public Economics* 32 (2), 133-158.

Tax Policy Center, Urban Institute & Brookings Institution, 2018. “Statistics for Consumption Taxes.” Brookings, Washington, DC. Available at: https://www.taxpolicycenter.org/statistics

Tiwary, Ruchita, 2011. *Determinants of Tax Pass-Through Rates: A Study of the U.S. Beer Industry*. Master’s Thesis. University of Massachusetts Amherst, Amherst, MA. Available at: https://scholarworks.umass.edu/resec_theses/

Tremblay, Mark J. and Victor J. Tremblay, 2017. “Tax Incidence and Demand Convexity in Cournot, Bertrand and Cournot-Bertrand Models.” *Public Finance Review* 45 (6), 748-770.

West, Douglas S., 2000. “Double Marginalization and Privatization in Liquor.” *Review of Industrial Organization* 16 (4), 399-415.

World Health Organization, 2010. *Global Strategy to Reduce the Harmful Use of Alcohol*. WHO, Geneva, CH. Available at: http://www.who.int/substance_abuse/activities/gsrhua/en/

Xuan, Ziming, Frank J. Chaloupka, Jason G. Blanchette, Thien H. Nguyen, et al., 2015. “The Relationship between Alcohol Taxes and Binge Drinking: Evaluation New Tax Measures Incorporating Multiple Tax and Beverage Types.” *Addiction* 110 (3), 441-450.

Young, Douglas J. and Agnieszka Bielinska-Kwapisz, 2002. “Alcohol Taxes and Beverage Prices.” *National Tax Journal* 55 (1), 57-73.

Table 1. Systematic Review: Alcohol Tax Pass-Through Studies by Beverage

Beer tax studies	Country, data period & type. Basic results.	Summary of beer tax pass-through rates (se) (best estimate rates in bold)
Ally et al. (2014)	United Kingdom (UK), 2008-2011, weekly on-line supermarket prices. **Fully-shifted on average.**	Average for 11 beer nominal price segments, **1.03 (0.07)**.
Ardalan & Kessing (2017)	28 European (EUR) countries, 1996-2016, monthly Eurostat prices. **Undershifted.**	Beer tax coefficients adjusted for consumer's share. Initial rate with all controls, **0.78 (0.10)**. Total rate with controls, 0.89 (na).
Baker & Brechling (1992)	UK, 1973-1990, quarterly price index. **Under- and Fully-shifted.**	Beer pass-through across all tax changes, **1.02 (0.25)**. Beer pass-through for larger "real" tax changes, **0.70 (0.12)**.
Bako & Berezvai (2013)	Hungary (HU), 2000-2011, monthly average domestic prices, VAT filtered out. **Overshifted.**	Domestic beer excise real tax pass-through, **1.65 (0.22)**. Wholesale prices are fully shifted. Suggests results reflect "double marginalization."
Bergman & Hansen (2017)	Denmark (DK), 1997-2005, monthly brand prices. **Overshifted.**	Beer tax pass-through for all tax changes, **3.84 (1.00)**; contemporaneous rate, 3.63 (0.79).
Carbonnier (2013)	France (FR), 1995-97, monthly price index and baseline prices. **Overshifted.**	Contemporaneous beer pass-through for excise tax with cost controls, **1.20 (0.09)**.
Chua (2000)	US, 1982-95, ACCRA prices & Infoscan prices for brands. **Under-, Over-, and Fully-shifted**.	ACCRA, **1.22 (0.25)** for nominal and 1.41 (0.26) for real beer tax; Infoscan (2 lags): all segments, **1.02 (0.14)**.; popular, 0.56 (0.15); light, 1.21 (0.15); premium, 1.17 (0.15); and super, 1.05 (0.14).
Hanson & Sullivan (2015)	US, 4 southeast states, 2010. 13 weeks of phone-survey store prices. **Undershifted.**	All tax pass-throughs are negative. Border effects important at < 50 miles. Bud Light, -0.25 (0.17, ns); Miller Lite, -0.21 (0.18, ns). Not included.
Harding et al. (2010)	US, 2006-07, weekly Nielsen Homescan prices with border controls. **Undershifted.**	Beer pass-through for all consumers is small, possibly due to trading-down in quality. At mean distance from lower-tax borders, **0.62 (0.14)**.
Hunt et al. (2010)	UK, 1987-2009, annual prices. **Under- and Overshifted.**	Lager beer elasticity, 1.31 (na); bitters, 1.33 (na); lager in cans, 0.85 (na). Not included in meta-analysis; reports elasticities.
Hunt et al. (2018)	US, 2000-12, annual ACCRA real prices by state. **Overshifted**	Average beer state pass-through rate is **1.75 (0.59)** before the Great Recession of 2008-09. Average rate after Great Recession is 1.24 (0.48).
Kenkel (2005)	US, Alaska (AK), 2002-03, monthly brand prices. **Overshifted.**	Beer on-premise ave. real tax pass-through, 2.25 (na); off-premise ave., 1.67 (na). Not included in meta-analysis; no standard errors.

Mathes & Carpenter (2015)	US, 1982-2012, quarterly ACCRA city-level prices. **Under- and Overshifted**	Beer pass-through real rate, **1.10 (0.41)**. Adding quadratic trend, **0.68 (0.32)**.
Niskanen (1962)	US, 1934-41 & 1947-60. Brands. **Undershifted.**	Beer pass-through real rate for leading brands, **0.81 (0.59, ns)**.
Parsons (2007).	Japan (JP), 1979-1994. Wholesale prices are **Overshifted** in long-run. Retail prices uncertain.	Long-run real wholesale price pass-through elasticity 1.09 (na), based on four tax changes (three hikes, one cut) in 1982-94. Not included; no standard errors.
Pipoblabanan (2008)	US, 1953-2002, annual price index. Federal tax is **Overshifted.** State taxes are **Undershifted**.	Pass-through rate for real Federal tax, **1.45 (0.26)**. Ave. of state real taxes, **0.66 (1.32, ns**).
Rabinovich et al. (2012)	Ireland (IR), Finland, Latvia, and Slovenia (SL), one monthly price & price indexes. **Undershifted.**	Pooled regression for four countries: real beer price off-premise, **0.83 (0.32)**.
Russell & Van Walbeek (2016)	South Africa (SA), 2001-14, monthly brand prices (excl. 2006-07). **Overshifted.**	Adjusted for VAT, all beer, **3.00 (0.19)**. Brand-sizes yield overshifting for all sizes; excluded from meta-analysis due to absence of cost controls.
Shang et al. (2018)	31 OECD countries, 2003-2016. City-level price data. **Fully- and Overshifted**.	Beer mean-price, 1.26 (0.31) and **1.01 (0.18)**. Average of 14 estimates, 1.12.
Shrestha & Markowitz (2016)	US, 2000-2014, quarterly city ACCRA prices. **Overshifted.** Outlets possibly endogenous.	Beer real tax pass-through, **1.72 (0.32)**; nominal, 1.78 (0.28). 1991 Federal hike, real tax, **1.85 (0.24)**-2.20 (0.32); nominal, 2.32 (0.35)-2.53 (0.44).
Stehr (2007)	US, 1990-2004, third quarter ACCRA prices aggregated to state level. **Undershifted.**	Beer state tax pass-through, **0.94 (0.39)**. Unclear how 1991 Federal tax hike was handled.
Tiwary (2011)	US, 1990-91, quarterly city Infoscan brand prices. **Overshifted on average.**	Federal 1991 hike by price: budget, 1.85 (0.83); light, 2.06 (0.73); import, 3.19 (1.66, ns); premium, 2.14 (0.65); super, 2.12 (1.03). 63 brands, **2.04 (0.57)**.
Young & Bielinska-Kwapisz (2002)	US, 1982-97, quarterly ACCRA city prices aggregated to state-level. **Overshifted.**	Beer state real tax pass-through, 1.52 (0.56) including lag terms. Without insignificant lag terms, **1.71 (0.36)**.
Wine tax studies	**Country, data period & type. Basic results.**	**Summary of wine tax pass-through rates (best estimates in bold)**
Ally et al. (2014)	UK, 2008-2011, weekly on-line supermarket prices. **Overshifted on average.**	Ave. for all 11 wine nominal price segments, **1.09 (0.07)**.
Baker & Brechling (1992)	UK, 1973-1990, quarterly price index. **Under- Over- and Fully-shifted.**	Wine excise duty is overshifted, 1.64 (na), with an initial rate of **1.04 (0.19)**. For larger real duty changes, wine tax is undershifted, **0.62 (0.11)**.

Chua (2000)	US, 1982-95, city ACCRA prices. **Overshifted**.	Wine state real excise tax is overshifted, **2.27 (0.52)**.
Hunt et al. (2010	UK, 1987-2009 and 1996-2009. **Undershifted.**	Table wine elasticity, 0.86 (na). Not included; reports elasticities.
Kenkel (2005)	US, Alaska (AK), 2002-03, monthly brand prices. **Overshifted.**	Wine real price pass-through: red, 3.27 (na); and white, 4.19 (na). All wines, 3.73 (na). Not included in meta-analysis; no standard errors.
Loretz & Sullivan (2015)	26 EUR nations, 1994-2013, annual prices from trade source. **Undershifted.**	Wine pass-through rate, 0.09 (0.05, ns). Not included in meta-analysis; poor data quality.
Niskanen (1962)	US, 1934-41 & 1947-60. Brands. **Overshifted.**	Wine real price pass-through rate for leading brands, **1.43 (0.57)**.
Rabinovich et al. (2012)	Ireland (IR), 1993-2011, one monthly price & monthly price index. **Undershifted.**	Ireland wine off-premise, 0.33 (na); and wine on-premise, 0.18 (na). Results not included in meta-analysis; no standard errors.
Shang et al. (2018)	31 OECD countries, 2003-2016. City-level price data. **Overshifted.**	Wine mean-price, 2.67 (0.45) and **2.09 (0.94)**. Average of 13 estimates, 2.32.
Young& Bielinska-Kwapisz (2002)	US, 1982-97, quarterly ACCRA city prices aggregated to state-level. **Overshifted.**	Wine real price pass through rate, license states, **1.24 (0.43)**; control states, **2.11 (0.48)**.
Spirits tax studies	**Country, data period & type. Basic results.**	**Summary of spirits tax pass-through rates (best estimates in bold)**
Ally et al. (2014)	UK, 2008-2011, weekly on-line supermarket prices. **Fully-shifted on average.**	Average for all 11 spirits nominal price segments, **1.04 (0.08)**.
Baker & Brechling (1992)	UK, 1973-1990, quarterly price index. **Under-shifted.**	Spirits excise duty is undershifted, **0.91 (0.05)**. Cross-price effects with beer and wine are not significant.
Barzel (1976)	US, New York state, 1971. Prices for 11-12 spirits brands. **Overshifted.**	Overshifting for 11-12 spirits brands. Ave. pass-through, 1.31 (0.40)-**1.51 (0.43)**.
Bergman & Hansen (2017)	Denmark (DK), 1997-2005, monthly brand prices. **Undershifted.**	Spirits excise tax pass-through with four lags, **0.72 (0.07)**; contemporaneous rate, 0.78 (0.08). No border effects with Germany.
Carbonnier (2013)	France FR), 1995-1997, monthly price index with baseline prices. **Under- and Overshifted.**	For excise tax, there is initial overshifting for whiskey, **1.13 (0.10)**. For aperitif, lower bound rate is 0.85 (0.07).
Chua (2000)	US, 1982-95, annual city ACCRA prices for license states. **Undershifted**.	Real excise tax pass-through rate for spirits is **0.72 (0.32)** for license states. Lag effects are unimportant.

Conlon & Rao (2016)	US, Connecticut (CT) & Illinois (IL), 2008-2012, monthly. Nielsen Homescan prices for brand-flavor-size of spirits. **Over- and Fully-shifted.**	Ave. prices in CT increased at rate of 1.26 (0.20) in third month but declined to **1.01 (0.26)** after six months. Retail prices on smaller-sized products < 1750mL are overshifted. For IL, three- and six-month rate are 0.96 (0.04) & **1.27 (0.05)**.
Cook (1981)	US, 1960-1975. Annual ave. price data for license states. **Overshifted.**	Median pass-through for 39 leading brands is 1.19 (na). Not included in meta-analysis; no standard errors. Comments tax changes are likely exogenous.
Hindriks & Serse (2018)	Belgium (BE) & France (FR control stores), 2015-2016, monthly. Scanner prices from major supermarket chain. **Over- and Fully-shifted.**	Long-run pass-through rate for two vodka brands (low, medium-priced), **1.16 (0.09)** & 1.07 (0.04); one whiskey brand, **0.99 (0.09)**; & one rum brand, 1.09 (0.05). Average rates are vodka, 1.25 (0.05) and whiskey, 0.99 (0.09).
Hunt et al. (2010)	UK, 1987-2009 for whiskey and 1996-2009 for vodka. Annual prices. **Over and Fully-shifted.**	Whiskey elasticity, 1.21 (na); and vodka elasticity, 0.95 (na). Results not included in meta-analysis; reports elasticities.
Kenkel (2005)	US, Alaska (AK), 2002-03, monthly brand prices. **Overshifted.**	On-premise real spirits price ave., 3.28 (na); off-premise ave., 1.89 (na). Not included in meta-analysis; no standard errors.
Loretz & Zwirn (2015)	26 EUR nations, 1994-2013. Annual prices from trade source. **Over- and Fully-shifted.**	Pass-through for 26 European nations, all spirits, **1.04 (0.05)**; gin, 1.05 (0.07); and vodka, **1.28 (0.05)**.
Niskanen (1962)	US, 1934-1941 & 1947-1960. **Undershifted.**	Pass-through for leading spirits brands based on annual prices, **0.82 (0.05)**.
Rabinovich et al. (2012)	Ireland (IR), Finland, Latvia, & Slovenia (SL), one monthly price & price indexes. **Undershifted.**	Pooled regression for four countries: real vodka price off-premise, **0.94 (0.36)**.
Shang et al. (2018)	31 OECD countries, 2003-2016. City-level price data. Four types of spirits (cognac, gin, whisky, liqueur). **Under-, Over-, and Fully shifted.**	Diversity of estimates prevents inclusion in analysis (no results for average prices). Means by beverage: cognac, 2.03; gin, 1.01; Scotch, 1.24; and liqueur, 2.52.
Siegel et al. (2013)	US, 2012. Online prices for 45 brands sold at 177 stores in 8 license states. **Undershifted.**	Spirits pass-through rates are 0.86 (0.22)-**0.93 (0.22)**. Includes potentially endogenous variables for per capita adult consumption and outlet density.
Stehr (2007)	US, 1990-2004, third quarter ACCRA prices aggregated to state-level. **Overshifted**	Spirits pass-through in license states, **1.56 (0.38)**. Unclear how 1991 Federal tax hike was handled.
Young& Bielinska-Kwapisz (2002)	US, 1982-97, quarterly ACCRA city prices aggregated to state-level. **Overshifted.**	Spirits real price pass-through in license states, **1.64 (0.50)**; & control states, **1.61 (0.60)**.

Notes: Fully shifted pass-through rates are assumed to be in the range of 0.95-1.05. Abbreviations: na is not available or not applicable; ns indicates not significantly different from zero; Organization for Economic Cooperation and Development (OECD).

Table 2. Pass-Through Rates for Beer – Weighted Means

Beer tax studies (country, type, page source)	Pt. est. (se, t-stat.)	95% C.I.
Ally et al. (2014), UK – ave. of 11 price points (app., p8)	1.03 (0.07, 14.7)	0.89-1.17
Ardalan & Kessing (2017), EUR – rgr. 5 rate (adj., p18)	0.78 (0.10, 7.8)	0.58-0.98
Baker & Brechling (1992), UK – revalorized (p57 & 63)	1.02 (0.25, 4.1)	0.53-1.51
Baker & Brechling (1992), UK – real change (p57 & 63)	0.70 (0.12, 5.8)	0.46-0.94
Bako & Berezvai (2013), HU – domestic prices (p4)	1.65 (0.22, 7.5)	1.22-2.08*
Bergman & Hansen (2017), DK – with 4 lags (p19)	3.84 (1.00, 3.8)	1.88-5.80*
Carbonnier (2103), FR – contemp. rate (p854)	1.20 (0.09, 13.3)	1.02-1.38*
Chua (2000), US – ACCRA city prices, rgr. 6 (p61)	1.22 (0.25, 4.9)	0.73-1.71
Chua (2000), US – 1991 Fed. tax, 35 brands (p. 144)	1.02 (0.14, 7.3)	0.75-1.29
Harding et al. (2010), US – mean distance (p20 & 33)	0.62 (0.14, 4.4)	0.35-0.89
Hunt et al. (2018), US, ACCRA state prices (p11)	1.75 (0.59, 3.0)	0.59-2.91
Mathes & Carpenter (2015), US – ACCRA city (p75)	1.10 (0.41, 2.7)	0.30-1.90
Mathes & Carpenter (2015), US – with quad trend (p75)	0.68 (0.32, 2.1)	0.05-1.31
Niskanen (1962), US – brand data (p43)	0.81 (0.59, 1.4)	-0.35-1.97
Pipoblabanan (2008), US – real ave. state tax (p64)	0.66 (1.32, 0.5)	-1.93-3.25
Pipoblabanan (2008), US – real Fed tax (p64)	1.45 (0.26, 5.6)	0.94-1.96
Rabinovich et al. (2012), 4 countries – (p29)	0.83 (0.32, 2.6)	0.20-1.46
Russell & Van Walbeek (2016), SA – all beer (p565)	3.00 (0.19, 15.8)	2.63-3.37*
Shang et al. (2018), OECD – SUR model (p24)	1.01 (0.18, 5.6)	0.66-1.36
Shrestha & Markowitz (2016), US – real state tax (p1955)	1.72 (0.32, 5.4)	1.09-2.35*
Shrestha & Markowitz (2016), US – 1991 Fed tax (p1959)	1.85 (0.24, 7.7)	1.38-2.32*
Stehr (2007), US – ACCRA state prices (p90)	0.94 (0.39, 2.4)	0.18-1.70
Tiwary (2011), US – 1990-91, ave. 63 brands (p25)	2.04 (0.57, 3.6)	0.92-3.16
Young & Bielinska-Kwapisz (2002), US – no lags (p67)	1.71 (0.36, 4.8)	1.00-2.42*
Summary statistics – Beer tax studies		
FES mean (se) – 24 best estimates obs.	1.10 (0.04)	1.02-1.17*
RES mean (se) – 24 best estimates obs.	1.28 (0.11)	1.06-1.50*
FES mean (se) – 40 obs.	1.14 (0.03)	1.08-1.20*
RES mean (se) – 40 obs.	1.40 (0.09)	1.22-1.58*

Notes: Asterisks indicate significantly different from one; se is standard error; obs. is observations. Random-effects use method-of-moments to calculate between-study variance (mixed-effects). All weighted means obtained using *Comprehensive Meta Analysis v3* (Borenstein et al., 2015a); some table entries may reflect rounding errors. Confidence intervals (C.I.) reported in third column.

Table 3. Pass-Through Rates for Wine and Spirits – Weighted Means

Wine tax studies (country, type, page source)	Pt. est. (se, t-stat)	95% C.I.
Ally et al. (2014), UK – ave. of 11 price points (app., p8)	1.09 (0.07, 15.6)	0.95-1.23
Baker & Brechling (1992), UK – revalorized (p57 & 63)	1.04 (0.19, 5.5)	0.67-1.41
Baker & Brechling (1992), UK – real change (p57 & 63)	0.62 (0.11, 5.6)	0.40-0.84
Chua (2000), US – ACCRA city prices, rgr. 2 (p62)	2.27 (0.52, 4.4)	1.25-3.29*
Niskanen (1962), US – brand data (p43)	1.43 (0.57, 2.5)	0.31-2.55
Shang et al. (2018), OECD – SUR model (p24)	2.09 (0.94, 2.2)	0.25-3.93
Young & Bielinska-Kwapisz (2002), US – license (p69)	1.24 (0.43, 2.9)	0.40-2.08
Young & Bielinska-Kwapisz (2002), US – control (p69)	2.11 (0.48, 4.4)	1.17-3.05*
Spirits tax studies (country, type, page source)	**Pt. est. (se, t-stat)**	**95% C.I.**
Ally et al. (2014), UK – ave. of 11 price points (app., p8)	1.04 (0.08, 13.0)	0.88-1.20
Baker & Brechling (1992), UK – revalorized (p57 & 63)	0.91 (0.05, 18.2)	0.81-1.01
Barzel (1976), US – 11 brands at retail (p1196)	1.51 (0.43, 3.5)	0.67-2.35
Bergman & Hansen (2017), DK – with 4 lags (p19)	0.72 (0.07, 10.3)	0.58-0.86
Carbonnier (2013), FR – contemp. rate, whiskey (p857)	1.13 (0.10, 11.3)	0.93-1.33
Chua (2000), US – ACCRA, license states, rgr. 2 (p63)	0.72 (0.32, 2.3)	0.09-1.35
Conlon & Rao (2016), US – CT six-month rate (p40)	1.01 (0.26, 3.9)	0.50-1.52
Conlon & Rao (2016), US – IL six-month rate (p41)	1.27 (0.05, 25.4)	1.17-1.37*
Hindriks & Serse (2018), BE – vodka C (Tbl 7)	1.16 (0.09, 12.9)	0.98-1.34
Hindriks & Serse (2018), BE – whiskey ave. (Tbl 3)	0.99 (0.09, 11.0)	0.81-1.17
Loretz & Zwirn (2015), 26 EUR nations – all spirits (p8)	1.04 (0.05, 20.8)	0.94-1.14
Loretz & Zwirn (2015), 26 EUR nations – vodka (p8)	1.28 (0.05, 25.6)	1.18-1.38*
Niskanen (1962), US – brand data (p43)	0.82 (0.05, 16.4)	0.72-0.92
Rabinovich et al. (2012), IR & SL – vodka (p29)	0.94 (0.36, 2.6)	0.23-1.65
Siegel et al. (2013), US – brands, no controls (p426)	0.93 (0.22, 4.2)	0.50-1.36
Stehr (2007), US – ACCRA prices, license states (p90)	1.56 (0.38, 4.1)	0.82-2.30
Young & Bielinska-Kwapisz (2002), US – license (p68)	1.64 (0.50, 3.3)	0.66-2.62
Young & Bielinska-Kwapisz (2002), US – control (p68)	1.61 (0.60, 2.7)	0.43-2.79
Summary statistics – Wine and spirits tax studies		
FES mean (se) – 8 obs., wine only obs.	1.00 (0.06)	0.88-1.12
RES mean (se) – 8 obs., wine only obs.	1.21 (0.17)	0.88-1.54
FES mean (se) – 18 obs., spirits only obs.	1.04 (0.02)	1.00-1.08*
RES mean (se) – 18 obs., spirits only obs.	1.05 (0.06)	0.93-1.17
Summary statistics – Wine-spirits tax studies		
FES mean (se) – 26 best obs., wine-spirits obs.	1.04 (0.02)	1.00-1.08*
RES mean (se) – 26 best obs., wine-spirits obs.	1.06 (0.05)	0.96-1.16
FES mean (se) – 36 obs., wine-spirits obs.	1.03 (0.01)	1.01-1.05*
RES mean (se) – 36 obs., wine-spirit obs.	1.04 (0.04)	0.96-1.12

Notes: Asterisks indicate significantly different from one; se is standard error; obs. is observations; app. is appendix Random-effects use method-of-moments to calculate between-study variance (mixed-effects). All weighted means obtained using *Comprehensive Meta Analysis v3* (Borenstein et al., 2015a); some table entries may reflect rounding errors. Confidence intervals (C.I.) reported in third column.

Table 4. Meta-Regressions for Publication Bias

Variable	(1) Beer	(2) Beer	(2) Wine–spirits	(4) Wine–spirits	(3) All alcohol	(6) All alcohol
Intercept	0.837 (0.120)*	0.959 (0.162)*	0.986 (0.046)*	0.913 (0.054)*	0.948 (0.039)*	0.888 (0.069)*
Precision – std. error	1.879 (0.602)*	1.498 (0.468)*	0.661 (0.578)	1.175 (0.349)*	1.241 (0.369)*	1.570 (0.302)*
R-square	0.204	0.210	0.037	0.030	0.133	0.150
F-stat. (p)	9.760 (0.003)	10.23 (0.003)	1.310 (0.261)	11.34 (0.002)	11.33 (0.001)	27.00 (0.000)
Sample size	40	40	36	36	76	76
Model	fixed	random	fixed	random	fixed	random
95% C.I. for intercept	0.60 – 1.07	0.64 – 1.28	0.90 – 1.08	0.81 – 1.02	0.87 – 1.02	0.75 – 1.02

Notes: Standard errors on parentheses; asterisks indicate statistically different from zero at the 95% confidence level. Results obtained using *Comprehensive Meta Analysis v3* (Borenstein et al., 2015a) and *Stata/IC 15.1*. Random-effects use method-of-moments. For fixed-effect standard errors, weighted least-squares estimates are used; see Rhodes (2012, p. 39) for discussion. Additional regressions reported in Appendix B indicate no significant effects of non-US estimates or micro data on the conclusions; e.g., a dummy variable for country-origin is insignificant after accounting for precision. As a test of non-linearity in bias, a quadratic term for precision did not yield significant coefficient results. Random-effects results not affected by method of estimation.