Tax Design and Incidence in Sports Betting

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Abstract

Most U.S. states with legal sports betting tax sportsbook revenue. Since sportsbooks have minimal costs per dollar wagered, this ad valorem tax behaves like a profits tax, and sportsbooks do not raise the price of betting in high-tax states. Instead, they spend less on TV advertising. We estimate the causal effect of such advertising reductions on sportsbook deposits. We use our estimates to compare the ad valorem tax to a specific tax. The specific tax does raise the price of betting, so it discourages far more gambling. In a calibration incorporating standard tax burdens and internalities from sports betting, the specific tax's corrective benefits do not outweigh its greater harms on consumers and firms: the marginal excess burden of the ad valorem tax is one-ninth that of a revenue-equivalent specific tax.

JEL Codes: H22, L83, H21, H23, M37

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1 Introduction

As of 2025, 39 states have legalized sports betting, and Americans wager over $165 billion on sports per year, more than on state-run lotteries [North American Association of State and Provincial Lotteries, 2025, American Gaming Association, 2026]. State governors often cite increased tax revenue as a justification for legalization; Kentucky governor Andy Beshear pitched it as a way to raise revenue "without raising taxes on working families" [Beshear, 2020]. Most tax revenue from sports betting is raised by a tax on sports betting operators' revenue. These taxes raised over $3B in 2025 at tax rates ranging from Iowa's 6.75% to New York's 51%. In New York, sports betting tax revenue exceeds combined revenue from state alcohol and tobacco taxes.

But legal sports betting also imposes unpriced harms. Past work shows that bettors underestimate their future losses, and that household balance sheets deteriorate when states legalize sports betting [Brown et al., 2025, Baker et al., 2024, Hollenbeck et al., 2025]. Ohio governor Mike DeWine said signing the bill legalizing sports betting was his biggest mistake as governor, adding "it's a huge problem among young males up to 45... we have many of them addicted... spending money that they do not have" [Pelzer, 2026]. These harms are a corrective rationale for taxing sports betting. Corrective and revenue-raising motives for taxation are generally in tension. A corrective tax only benefits society to the extent that it reduces the harmful activity, but tax-induced consumption reductions erode the tax base and limit the revenue raised. In this paper, we combine simple theory and new data to study how ad valorem taxes on sports betting affect consumers and sportsbooks. We then evaluate the tax's welfare consequences relative to a specific tax on dollars wagered.

We first define prices, quantities, and revenues in the sports betting industry.[1] Sportsbooks post odds for sporting events and take wagers at those odds. These odds are not actuarially fair. Instead, sportsbooks set odds so that a bettor wagering a dollar on each side of a bet is guaranteed to lose money. In the U.S., a dollar wagered results in an average loss of about 9.5 cents; this average loss is the price (p). Quantities (Q) are defined as total dollars wagered. Revenue (pQ) is the product of price and dollars wagered; this revenue is what a sportsbook has to pay its expenses. The distinction between Q and pQ is worth emphasizing because, unlike in most industries, both are denominated in dollars. Suits [1979] illustrates this distinction: "the total volume of wagers handled is no more 'revenue' to a betting establishment than the total value of houses traded constitutes 'revenue' to a real estate agent."[2]

[1] Prediction markets such as Polymarket and Kalshi, which began listing sports contracts in 2025 and claim exemption from state betting taxes, are outside this paper's scope.

[2] See Section 2 for a worked example of how odds map to the price.

Before turning to the data, we use a stylized model to study how a profit-maximizing sportsbook should set prices and advertising under an ad valorem tax. Under zero marginal cost, a tax on revenues leaves optimal price unchanged but lowers optimal advertising, two implications that will guide our empirics. The optimal price is unchanged because an ad valorem tax behaves like a profits tax — a result that holds in any standard model with zero marginal cost. We think this implication is underappreciated, despite being known since at least Cournot [1838] in the monopoly case.[3] Advertising is different: the tax reduces after-tax marginal revenue per unit of advertising but not its cost, so optimal advertising falls. Abi-Rafeh et al. [2025] also make the point that ad valorem taxes reduce the incentive to advertise by reducing post-tax margins. This mechanism mirrors classic results showing ad valorem taxes distort product quality more than specific taxes [Barzel, 1976]. A specific tax should still pass through to prices, as is standard, because it simply acts as a marginal cost increase.

Our first contribution is to show empirically that ad valorem taxes on sports betting do not affect prices. For a given event, sportsbooks set the same odds in every state, regardless of the tax rate. Conditional on these uniform odds, sportsbooks could still raise average prices in high-tax states through two channels. First, they could tilt the menu of wagers offered in high-tax states toward worse-odds bets. Even though everyone would see the same price for the same wager, the dollar-weighted average price faced by a high-tax state's bettors would rise. Second, sportsbooks could raise their single national price in response to a higher national average tax. We use New York's 2022 legalization, which raised the dollar-weighted national tax rate faced by DraftKings and FanDuel by 8.6 percentage points, to test the latter. We reject that either sportsbook raised prices enough to maintain its pre-New York-legalization post-tax margin. These results are consistent with our stylized model's prediction that ad valorem taxes do not affect the optimal price. As a contrast, a case study of Illinois's per-wager tax shows that sportsbooks passed the tax through as an add-on fee, qualitatively consistent with the model.

Having ruled out price responses to tax rates, we explore marketing responses next. Marketing is a natural place to look because it is a major expense for sportsbooks. DraftKings spent 18.6% of revenue on advertising in 2025, roughly eight times what the average large firm spends on paid media [Gartner, 2025].[4] Marketing is also locally adjustable: sportsbooks

[3] *In this case, if the commodity were produced and delivered without appreciable cost between producer and consumers, the price being determined by the condition that the producer shall derive the greatest possible profit... the presence of the constant factor* $(1-n)$ *will not alter the value of* p *in the least; the tax will fall wholly on the producer, and might go so far as to absorb all his net income.* [Cournot, 1838]

[4] Sample: 402 Chief Marketing Officers (CMOs) of companies with $1B or greater revenue. This survey finds the average firm spends 2.4% of revenue on paid media.

can choose where to spend on local television advertising and vary sign-up offers by state.

Our second contribution documents that marketing activity is lower in high-tax states: a one-percentage-point higher ad valorem tax rate is associated with a decline of roughly 1.9% of the cross-state mean. This correlation is robust to inclusion of controls that would likely influence advertising, including the number of competitors and how long sports betting has been legal in the state. Several sportsbook CEOs also discuss lowering marketing spend in high-tax states during earnings calls. Using new data we collected on sportsbooks' promotional sign-up offers, we also show promotional sign-up offers are lower in high-tax states. The findings are consistent with our model's prediction that ad valorem taxes reduce the incentive to advertise. They also highlight that the effect of ad valorem taxes on quantities depends on how sensitive demand is to advertising.

Our third contribution is to provide the first causal estimate of the effect of local TV advertising on demand for sports betting, measured by deposits to sportsbooks. We exploit plausibly exogenous variation in exposure to ads, an identification strategy pioneered by Shapiro [2018]. We find an ad elasticity for sports betting similar to his estimate for pharmaceuticals and to estimates for consumer packaged goods [Shapiro et al., 2021]. We also show sports betting ads operate primarily on the extensive margin (getting people to deposit at all) rather than the intensive margin (raising deposits per customer). Ad valorem taxes therefore modestly reduce sports betting deposits by reducing advertising.

Our fourth contribution is to quantify the welfare effects of the ad valorem tax on sports betting compared to a specific tax on dollars wagered, the standard corrective tool for goods with unpriced harms. To our knowledge, existing evaluations of sin taxes generally exclude the corrective role of tax-induced reductions in advertising, with Abi-Rafeh et al. [2025]'s study of the soda industry being one notable exception. To conduct this quantitative analysis, we use our empirical evidence to discipline some key parameters and calibrate others from the literature. We calibrate the internality to Brown et al. [2025]'s estimate of 4.97 cents per dollar wagered, i.e., bettors act as if the price of wagering \$1 was less than half of the true average price (9.46 cents 2023–2025).

On conventional efficiency grounds (ignoring the internality) the ad valorem tax is clearly preferred to the specific tax, because it barely distorts quantity. But this also means it has minimal corrective benefits. Per dollar of revenue raised, the specific tax causes a reduction in dollars wagered 8.2 times as large as the ad valorem tax. Despite the larger corrective benefits of the specific tax, the ad valorem tax is more efficient. In our main calibration, the ad valorem tax's marginal excess burden (i.e., the change in total surplus for a marginal dollar of revenue raised), inclusive of internalities, is $-\$0.17$ vs. $-\$1.65$ for a revenue-equivalent specific tax. The reason is that the specific tax imposes large conventional burdens on consumers and firms. Since sports bets are digital goods, the markup per dollar wager is large, and specific taxes have high efficiency costs in the presence of such market power [Weyl and Fabinger, 2013]. In an alternative specification where we ignore the digital nature of sports betting and assume that markups are similar to markups for other consumption goods, the specific tax is more efficient than the ad valorem tax.

Relationship to Literature

We contribute to the empirical literature on sports betting, which has focused mostly on downstream harms, with limited attention to taxation — the primary justification states gave for legalization. One exception is Larsen et al. [2025], who argue that sports betting cannibalized state lottery sales, with the lost lottery tax revenue partially or fully offsetting the tax revenue raised from sports betting. Matsuzawa and Arnesen [2024] argue that sports betting legalization led to increased intimate partner violence. Several papers have found that legalizing sports betting harms household balance sheets [Baker et al., 2024, Hollenbeck et al., 2025, Goss and Mangrum, 2026]. Other work has documented that demand for sports betting may be driven by cognitive biases, such as overoptimism and self-control problems [Brown et al., 2025, Chegere et al., 2025, Donkor et al., 2025, Potenza et al., 2019]. Motivated by these findings, Brown et al. [2025] propose corrective taxes on sports betting. Kasinger [2024] studies a 5% specific excise tax on dollars wagered on sportsbooks in Germany. Kasinger finds pass-through was larger among firms that passed the fee on as an add-on price vs. those that posted tax-inclusive odds. Past work on sports betting advertising includes correlational evidence that ad exposure is associated with betting consumption [McGrane et al., 2023] and lab experiments showing that promotional inducements increase betting participation [Ó Ceallaigh et al., 2025].

Our findings relate to a small literature on how commodity taxes affect firms' incentive to advertise. Abi-Rafeh et al. [2025] show that ad valorem taxes reduce the incentive to advertise more than specific taxes. They show empirically that consumers who are price-sensitive also tend to be especially ad-sensitive, suggesting that a tax on sugar-sweetened beverages would reduce the incentive to advertise. Hua et al. [2024] find no significant effect of Philadelphia's specific tax on sugar-sweetened beverage on the associated firms' ad expenditures.

Our findings also contribute to the literature comparing ad valorem and specific taxes, reviewed by Keen [1998]. The comparison goes back to Cournot [1838]. Suits and Musgrave [1953] show that ad valorem and specific taxes are equivalent under perfect competition, while under monopoly an ad valorem tax is preferred. Delipalla and Keen [1992] extend the comparison to oligopoly and show that ad valorem taxation is generally preferred under imperfect competition. Our zero-marginal-cost setting is a sharp special case in which the ad valorem tax leaves price unchanged, a point made by Cournot [1838] and explored further in the literature on digital taxation [Crémer, 2015, Bloch and Demange, 2018, Bourreau et al., 2018, Kind and Koethenbuerger, 2018, Cui, 2019].

The rest of the paper proceeds as follows. Section 2 provides institutional context. Section 3 presents a model of sportsbook taxation. Section 4 describes our data. Section 5 presents results on how firms respond to taxes. Section 6 studies how marketing influences demand. Section 7 calibrates the efficiency of prevailing sports betting taxes and compares to a hypothetical specific tax on dollars wagered. Section 8 concludes.

2 Market Structure and Unit Economics of the Sports Betting Industry

The sports betting market is dominated by a few national firms. As of August 2025, 65% of dollars were wagered at two firms: FanDuel and DraftKings, as Table A1 shows. 97% of dollars were wagered at one of eight firms. This concentration is bolstered by entry regulation; for example, Oregon, New Hampshire, and Rhode Island allow only one sportsbook to operate.

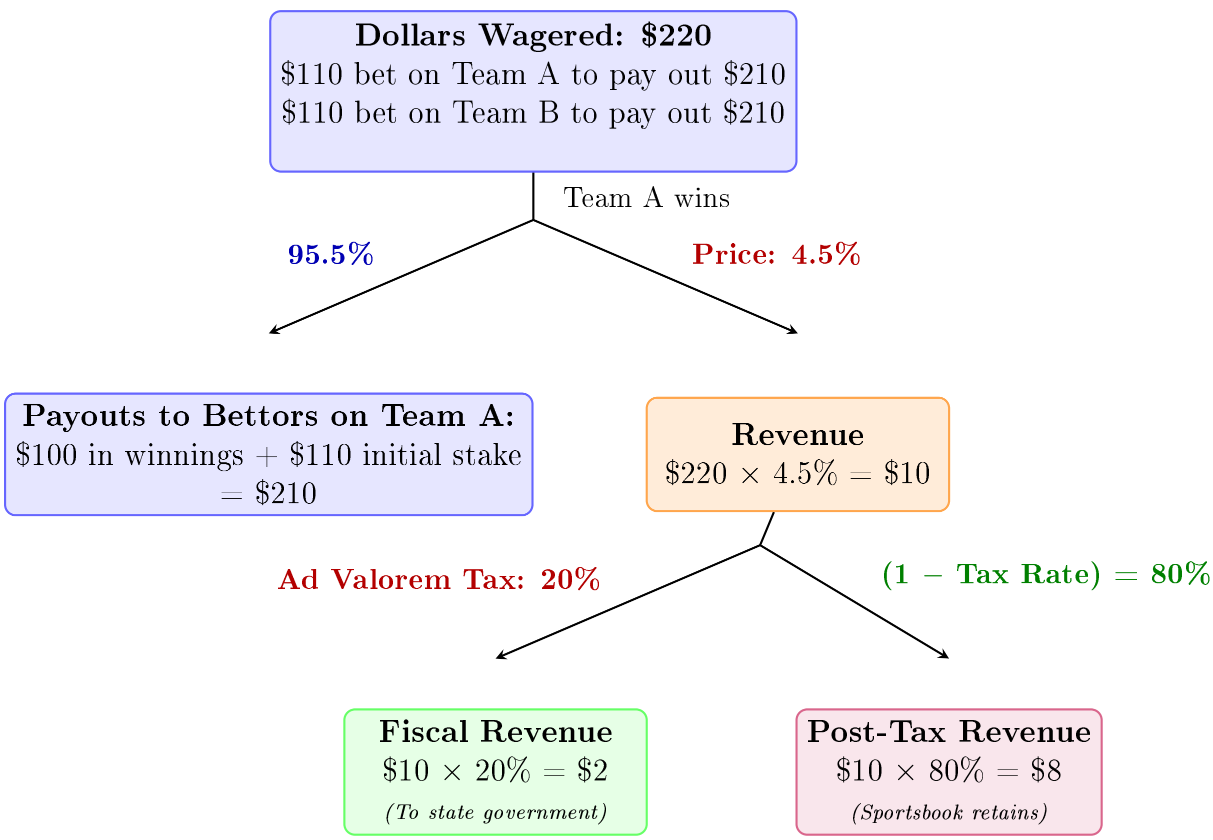
To trace through how a sportsbook makes money, we consider a stylized example in Figure 1. \$220 is wagered on a contest between evenly matched teams, with \$110 bet on each side. The \$220 wagered is the quantity. The odds offered determine the price. A common odds offer by sportsbooks would pay out \$210 (the \$110 stake plus \$100 in winnings) to the winning bettor while the losing bettor loses their stake. Regardless of who wins, the sportsbook's revenue ($p \cdot Q$) is \$10, so the price to wager a dollar is 4.5% ($p =$\$10/\$220). In almost every state, sportsbook revenue is the tax base. In Figure 1, the ad valorem tax rate is 20%; the sportsbook pays \$2 in taxes and retains \$8 to cover expenses such as advertising, promotional credits, salaries, and technology costs.

While ad valorem taxes are the dominant form of taxation of sportsbooks, two states assess other types of taxes. Illinois has both an ad valorem tax and a per-wager tax. Tennessee assesses a specific tax of 1.85 cents per dollar wagered. States also differ in whether promotional credits are deductible from the ad valorem tax base. This deductibility can cause appreciable effects on the *effective* tax rate firms pay, because as Table A2 shows, these promotional credits are large. For example, Pennsylvania and Michigan allow full deductibility of promotional credits, but New York does not allow any deduction. In addition to state taxes, all sportsbooks, online and retail, pay a federal excise tax of 0.25% on dollars wagered, equivalent to 25 cents per \$100 bet.

We can distinguish two types of marginal costs for sportsbooks. For a customer who already has an account, there is a *production cost* to provide one unit of quantity (a dollar wagered). There is also a cost to acquire that customer; we call this cost *marketing.* More than 96% of dollars wagered nationwide in 2025 were placed online [Gouker, 2026].

Because sports betting is mostly done online, production costs are small. Of the large sportsbooks, DraftKings offers the most detailed cost breakdown in its 10-K. Its gross margin, before state ad valorem taxes, was at least 80 cents per dollar of revenue.[5] The remaining 20 cents includes expenses like payment processing fees and chargebacks (when a customer disputes a credit card charge after wagering or withdrawing the money). The 80 cent figure is a lower bound: DraftKings records revenue-sharing payments to certain states as costs, but these function economically as taxes.

Figure 1: Example Sports Betting Revenue Flow



Notes: The scenario simulates a 20% ad valorem tax. This diagram excludes all sportsbook expenses other than payouts, such as advertising, promotional credits, salaries, and technology costs.

Sportsbook marketing costs are large; they consist of advertising and promotional credits.

[5] We compute this by (i) taking DraftKings' GAAP gross margin of 41%, which treats state gaming taxes as a cost, (ii) adding back state gaming taxes (35% of revenue), and (iii) adding back depreciation, amortization, and stock compensation (4% of revenue, combined), which we view as fixed costs.

In 2025, DraftKings spent 18.6% of revenue on advertising and Flutter (FanDuel's parent company) spent 12.5%. The average large firm spends only 2.4% of revenue on paid media [Gartner, 2025]. Even these figures understate how advertising-intensive sports betting is because accounting revenue overstates the revenue available to sportsbooks, as they must also pay state gaming taxes. DraftKings, the only sportsbook that breaks out state taxes in its financial filings, spends 28.5% of (revenue minus state gaming taxes) on advertising.[6] Even looking at sales and marketing—a broader category that includes advertising—only six NAICS industries average more than 12.5% of revenue [He et al., 2025].[7]

Promotional credits grant money to the bettor, or in some cases, increase the payout for a given bet. Examples include bonus bets (a free stake where the user keeps the winnings if the bet wins), deposit matches (the sportsbook matches a user's cash deposit), no-risk bets (the user is refunded if their bet loses), and odds boosts (an increased payout on a specified wager). Promotional credits fall into two categories: large sign-up offers for first-time bettors, worth over $500 at several sportsbooks, and smaller ongoing bonuses to retain customers. We estimate that DraftKings spent between $727M and $1.19B on promotional credits in 2024, and FanDuel spent between $726M and $1.33B. These figures imply sportsbooks' spending on promotional credits ranges from 36.9% to 113.5% of their advertising spend. We outline the assumptions going into this calculation in Table A2.

3 A Model of Sportsbook Taxation

Through a stylized model, we now review three standard points about the effects of ad valorem and specific taxes, in the context of sports betting.

- Firms do not change prices in response to an ad valorem tax.
- Firms cut advertising in response to an ad valorem tax.
- Firms raise prices in response to a specific tax.

3.1 Setup

Consider an industry with N symmetric, but differentiated, firms. Firm i chooses price $p_i \geq 0$ and advertising $A_i \geq 0$. Quantities demanded for firm i, Q_i, depend on a firm's

[6]Source: 2025 10Ks. DraftKings spent $1.125B on advertising (18.6% of $6,054.5M revenue; 28.5% of $3,943.9M revenue net of $2,110.6M gaming taxes); Flutter Entertainment (FanDuel's parent company) spent $2B globally across all brands.

[7]These industries are: medical equipment manufacturing (339); ground passenger transit (485); educational services (611); information services (519); publishing industries (513); and computing infrastructure providers, data processing, web hosting, and related services (518).

own and its rivals' prices (p_i, p_{-i}) and its own and rivals' advertising, (A_i, A_{-i}). Demand is downward-sloping in own-price, $\frac{\partial Q_i}{\partial p_i} < 0$, and own-advertising increases quantities demanded, $\frac{\partial Q_i}{\partial A_i} > 0$. Each firm faces constant marginal production cost $\kappa \geq 0$. Advertising costs are $c(A_i)$ with $c'(0) = 0$ and $c''(A_i) > 0$, reflecting an upward-sloping supply curve in the ads market. Pre-tax profits for firm i are thus:

$$\pi_i = (p_i - \kappa)\, Q_i(p_i, p_{-i}, A_i, A_{-i}) - c(A_i).$$

We focus on symmetric equilibria ($p_i = p^*$, $A_i = A^*$ for all i). Let $Q \equiv \sum_i Q_i$ denote aggregate quantities and $\varepsilon_Q(p) \equiv -pQ'(p)/Q(p)$ the market demand elasticity with respect to the symmetric price. To remain relatively agnostic on market structure, we parameterize firms' symmetric markup by an exogenous conduct parameter $\theta \in [0, 1]$ (following Bresnahan [1989]). We assume throughout that θ is constant, although this rules out certain models of pricing, including those derived from discrete choice with an outside option, such as standard differentiated-products Bertrand [Weyl and Fabinger, 2013]. θ is characterized by an elasticity-adjusted markup condition, where $\theta = 0$ is perfect competition and $\theta = 1$ is monopoly:

$$\frac{p^* - \kappa}{p^*}\, \varepsilon_Q(p^*) = \theta$$

We now adapt this general model to the case of sports betting. The price p_i refers to the odds inclusive of any fees. Quantities, Q_i, are dollars wagered. Advertising A_i refers to TV advertising. We make several substantive assumptions to make progress, justified by unique features of the sports betting industry.

First, we assume $\kappa = 0$: the firm has no variable costs in dollars wagered. Since sports betting is a digital good, firms have minimal variable production costs, likely no more than 20% of revenue, as we show in Section 2. Sportsbooks' remaining costs are either advertising or fixed costs, which drop out of the first-order condition. Without this assumption, the optimal price would change with the tax rate because the ad valorem tax would no longer behave like a gross profit tax.

Second, we assume demand is multiplicatively separable in prices and advertising: $Q_i = f(p_i, p_{-i}) \cdot g(A_i, A_{-i})$. This assumption is important, as it is the minimal restriction that ensures the firm's optimal price does not depend on the level of advertising. The assumption implies that advertising does not affect the price elasticity of demand. One stark microfoundation consistent with this assumption would be if ads work only on the extensive margin and randomly reach consumers, bringing more and more in each with average demand curve $f(p)$. We cannot test this directly, but we find evidence consistent with it. Consumers who make their first deposit in heavy advertising periods behave similarly to those who start betting in light-ad periods, both in deposits per month and retention six months later (Figure 6).[8]

Third, advertising is not tax-deductible. This is consistent with tax treatment of advertising spending in all states. This assumption ensures that advertising becomes less attractive as the tax rate rises. If advertising were deductible, the tax would be a pure profit tax and would not distort advertising.

Fourth, we make several regularity assumptions to ensure a unique optimum exists: (i) $\varepsilon_Q(p_i)$ is strictly increasing in p_i (Marshall's Second Law, Marshall [1920]) with $\varepsilon_Q(p_i) \to 0$ as $p_i \to 0$ and $\varepsilon_Q(p_i) \to \infty$ as $p_i \to \infty$; (ii) a firm's marginal return to advertising is weakly decreasing in total industry advertising, $\sum_j \partial^2 Q_i / \partial A_j \partial A_i \leq 0$; and (iii) Q_i is twice continuously differentiable in p_i.

3.2 An ad valorem tax

Assume firms are taxed on revenue at an exogenous tax rate $\tau \in [0, 1)$. After-tax profits are

$$\pi_i = (1 - \tau)\, p_i\, Q_i(p_i, p_{-i}, A_i, A_{-i}) - c(A_i)$$

Proposition 1. *(i) the symmetric equilibrium price p^* is independent of the ad valorem tax rate τ, and*
(ii) symmetric equilibrium advertising A^* is strictly decreasing in τ.

Proof sketch. The symmetric first-order condition (FOC) under conduct θ yields

$$(1 - \tau)\big[\theta\, Q(p^*) + p^*\, Q'(p^*)\big] = 0 \iff 1 - \frac{\theta}{\varepsilon_Q(p^*)} = 0$$

The tax rate τ drops out as it is a scalar multiplier on the FOC. τ also does not influence prices indirectly through advertising, since we have assumed advertising does not affect the elasticity of demand.

The advertising first-order condition is

$$(1 - \tau)\, p^*\, \frac{\partial Q_i}{\partial A_i}(p^*, A^*) = c'(A^*).$$

An increase in τ reduces the marginal benefit to advertising. Each firm responds by reducing its own advertising level. Firms reduce advertising because (a) the marginal benefit to one's

[8] Dubois et al. [2018], one of the few studies with data rich enough to quantify how advertising shifts price elasticities, also suggests our assumption is not unreasonable. Their study of the potato crisps market finds that setting a brand's advertising to zero would raise its own-price elasticity by only 1–3%, or about 0.01–0.07 in elasticity units.

own advertising, $\frac{\partial Q_i}{\partial A_i}$, is non-increasing in industry advertising A^*, by assumption, and (b) the marginal cost of advertising is strictly increasing in A^* (convex costs). See Appendix C.1 for the full proof. □

To clarify why sportsbooks' cost structure is important to the above result, suppose that the firm had positive marginal costs $\kappa > 0$. After-tax profits can be rearranged as:

$$\pi_i = (1-\tau)\left[p_i - \frac{\kappa}{1-\tau}\right] Q_i(p_i, p_{-i}, A_i, A_{-i}) - c(A_i). \tag{1}$$

The symmetric pricing FOC under conduct θ becomes

$$\frac{p^* - \kappa/(1-\tau)}{p^*}\, \varepsilon_Q(p^*) = \theta. \tag{2}$$

Equation (1) shows why Proposition 1's zero-price-effect result relies on zero marginal cost, and need not hold in industries with non-trivial production costs. The firm prices at a mark-up over its *effective* marginal cost, $\kappa/(1-\tau)$, which is increasing in τ. For example, Hollenbeck and Uetake [2021] find positive pass-through of an ad valorem tax on cannabis revenue. Appendix C.2 shows price is strictly increasing in the ad valorem tax rate whenever marginal cost is positive.

3.3 A specific tax

A specific tax of t per dollar wagered enters profit in exactly the same way as a marginal cost of t. For a firm with zero marginal costs, the firm problem under a specific tax is therefore identical to its problem with no ad valorem tax and marginal cost $\kappa = t$: setting $\tau = 0$ and $\kappa = t$ in equation (2) delivers the standard result of positive pass-through. Effective marginal cost rises one-for-one with t, and p^* is a markup over it. This implication is consistent with the introduction of a specific tax on sports betting in Germany, which passed through at a rate of 76%, through add-on fees [Kasinger, 2024]. In this model, a higher specific tax rate also reduces advertising, though this comparative static is not something we test empirically, so we relegate its proof to Appendix C.3.

In a stylized model of the sports betting industry, we have shown that an ad valorem tax should not influence price, but should lower advertising, and that a specific tax passes through to price. We introduce data in the next section to examine whether these implications hold.

4 Data

Tax rates. We get state ad valorem tax rates for each state from the Tax Foundation. For states with graduated tax rates, we use the average tax rate, calculated as total tax revenue divided by total sportsbook revenue.

State aggregate quantities and revenues. For aggregated dollars wagered, tax revenue, and sportsbook revenue by state, we use data from Legal Sports Report [Ramsey, 2025]. State-level data reflects total regulated sports betting, combining online and retail channels; most states report only aggregated figures. Nationwide, more than 96% of dollars were wagered online in 2025 [Gouker, 2026]. Because betting is overwhelmingly online, we focus on the 31 states and Washington, DC, where online sports betting is legal. We exclude Florida and Tennessee from all analyses. Florida does not report state-level revenue, likely because its only online book is tribal (Hard Rock), and Tennessee taxes dollars wagered rather than revenue. This leaves at most 29 states and DC for our analyses.

Prices. We use two price measures: realized state-level prices from regulator filings, computed as revenue divided by dollars wagered, and posted event-level NBA moneyline odds from the Odds API, a provider of odds data for professional sports bettors. We use odds from the 2021–2022 season. For each game, the data contains the odds offered by each major sportsbook, observed at approximately 11:00 AM Eastern on game day. We use NBA moneylines because they are a simple bet on the winner of a game, and because the NBA was the only major sport in season for at least two months before and after the tax increase we study in Section 5.1.

Marketing. We measure two types of marketing expenditure: television advertising and promotional sign-up offers.

Television advertising. For television advertising, we use Nielsen AdIntel [Shapiro et al., 2020] from 2018–2023. Nielsen AdIntel provides this data by firm for each Designated Market Area (DMA). DMAs are media markets constructed by Nielsen which correspond to a set of counties that receive the same local TV broadcasts. Many papers in economics use this data to study exposure to advertising [Shapiro et al., 2021, Gentzkow et al., 2024, Bordalo et al., 2025]. To our knowledge, this data has not previously been used in academic research on sports betting. For our sample, we focus on seven of the largest sportsbooks by market share: DraftKings, FanDuel, BetMGM, Caesars, BetRivers, Fanatics, and bet365, which together represent over 90% of dollars wagered (Table A1). Figure 5a excludes Fanatics and BetMGM due to data limitations, and the ads elasticity analysis in Section 6 applies additional sample restrictions described in Appendix B.1.2. We exclude ESPN Bet because it was rebranded to theScore Bet in late 2025 following the early termination of Penn Entertainment's agreement with ESPN.

Promotional offers. We build two new datasets of promotional offers.

The first has cross-state variation, but no time variation. We scraped screenshots from sportsbooks' websites from January 23, 2026. These provide sign-up offers for each sportsbook by state. This data is a cross-sectional snapshot; to our knowledge, this is the first dataset of sportsbook promotional offers by state.

The second is panel data, but does not contain cross-state variation. We constructed a panel of sportsbooks' new customer promotional sign-up offers from archival data. We scraped the Internet Archive's snapshots of Action Network, a promotional offer aggregator. For each sportsbook, we extract the offer displayed at the top of Action Network's page for that sportsbook. We have good coverage from July 2023 through November 2025 for three major sportsbooks: DraftKings, BetMGM, and FanDuel.

Promotional offers are not directly comparable in dollars: a $1,000 bonus bet cannot be converted to $1,000 USD with certainty because bonus bets pay out winnings but do not return the stake. To convert promotional offers to dollar values, we used conversion rates from DarkHorse Odds, a service which helps people take advantage of promotional offers. It has been covered in the Wall Street Journal [DarkHorse Odds, 2025, The Wall Street Journal, 2024]. DarkHorse Odds converts promotional offers into their expected value in dollars: bonus bets are valued at $0.70 on the dollar and risk-free bets at $0.50 on the dollar. Table A3 details each sportsbook's promotional offers and expected values in each state.

Deposits (quantity micro-data). In Section 6, we measure deposits to sports betting accounts using Consumer Edge, a panel of debit and credit card transactions with more than 93 million cards. This lets us see inflows into sports betting accounts, but not betting behavior. Consumer Edge's finest geography is the first 3 digits of the cardholder's billing zip-code (ZIP3), i.e., a collection of ZIP codes, so for most analyses we aggregate transactions to the sportsbook-ZIP3-month level. We benchmark Consumer Edge against state gaming commission data in Appendix B.2. We find that Consumer Edge deposits track state-level sportsbook revenues closely both over time (quarterly log correlation 0.97) and across states (cross-state log correlation 0.85), and that the New York legalization event is clearly visible in the Consumer Edge data. Larsen et al. [2025] use state-month aggregates and validate that the budget share spent on gambling increased in a state when sports betting was legalized. McCarthy et al. [2026] also use Consumer Edge data to measure sports betting demand.

5 Firm Responses to Taxes

5.1 Effects of Ad Valorem Taxes on Prices

The price of wagering a dollar is not associated with local ad valorem tax rates. This lack of association is because, for a given betting product, prices are set uniformly across states. That is, the odds of a bet never depend on the location of the bettor. Figure A2 shows an example of what we mean by a betting product: DraftKings posts identical odds in Illinois and Michigan despite sportsbooks paying very different ad valorem tax rates. FanDuel and BetMGM confirmed their uniform pricing practice to us via email, and a news article confirms DraftKings prices uniformly; we document these quotes in Table A4. Together these firms account for 79% of dollars wagered. Uniform pricing suggests the incidence of ad valorem taxes is primarily on firms, given the wide variation in ad valorem tax rates across states.

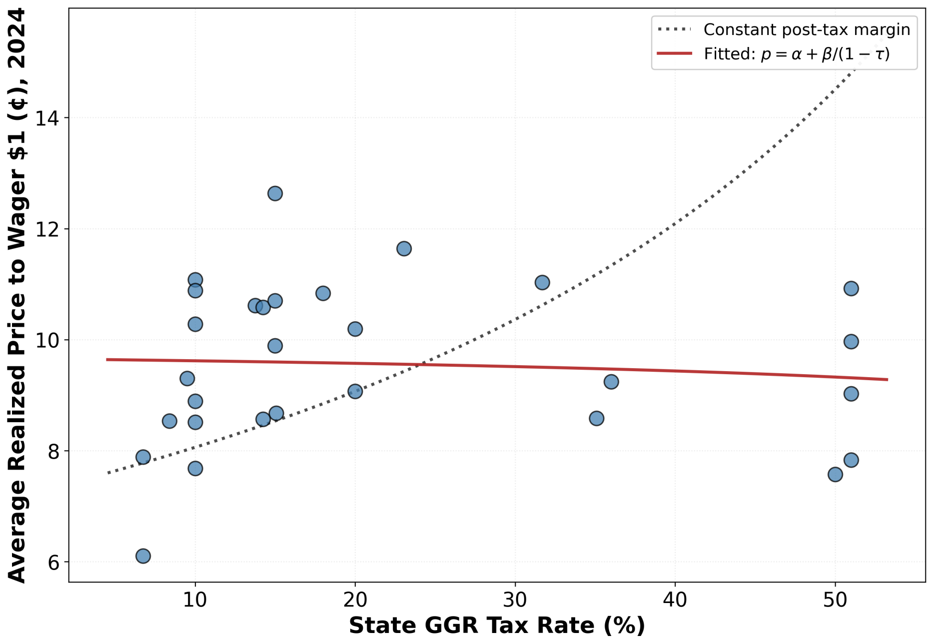
Even with uniform pricing, ad valorem taxes could still lead to higher prices in high-tax states in more subtle ways. We consider two possibilities. First, since sportsbooks offer a variety of wagers and the demand for wagers varies across locations, sportsbooks could increase prices in high-tax states by offering worse odds for wagers popular among residents of those states. A concrete example would be to offer worse odds on wagers popular among New York residents, like bets on the New York Yankees. In Figure 2a, we reject this hypothesis, finding no relationship between ad valorem tax rates and the average price to bet across states. Second, sportsbooks could adjust their national prices over time when their national tax exposure changes. For example, when New York legalized sports betting, the dollar-weighted average tax rate on U.S. wagers rose by 8.6 percentage points (from 15.0% to 23.6%) for both DraftKings and FanDuel. A sportsbook could have increased national prices in response to this event while still pricing uniformly across states. Figures 2b and 2c reject this hypothesis, showing that FanDuel and DraftKings did not raise prices immediately after launching in New York.

5.2 Case Study: Effect of a Per-wager Tax on Prices

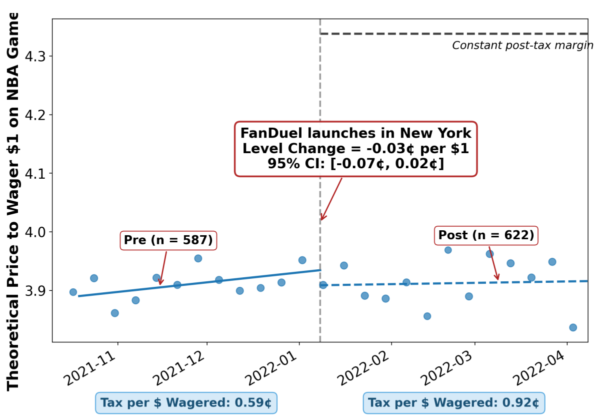
Our stylized model predicts that sportsbooks should not charge different prices in states with different ad valorem tax rates. An alternative explanation for the empirical fact that prices are the same in each state is technical limitations: sportsbooks may face an unmodeled uniform pricing constraint. Our model suggests a test for such a constraint: it implies sportsbooks should pass through a specific tax on dollars wagered.

We now turn to a case study of firm responses to a per-wager tax in Illinois. The tax, introduced on July 1, 2025, was \$0.25 on each of an operator's first 20 million online wagers

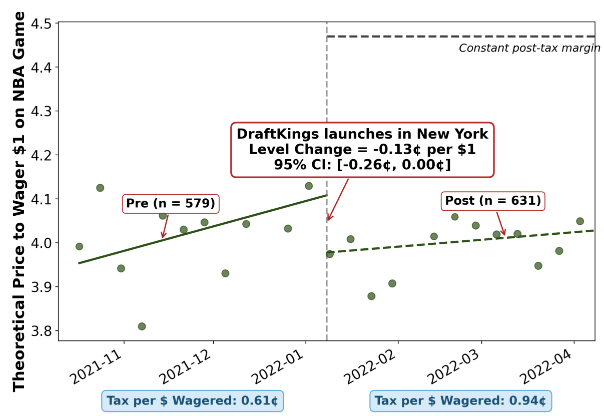
Figure 2: Associations between average price to bet and ad valorem tax rates across space and time



(a) Across states: 2024 average prices



(b) Over time: FanDuel



(c) Over time: DraftKings

Notes: Panel (a): average price to wager a dollar across 29 legal states in 2024; Florida excluded (tribal-only, no state reporting); Tennessee excluded (taxes dollars wagered, not revenue). The dotted curve shows what prices would look like if sportsbooks had the same post-tax margin in each state, anchored to Massachusetts. The y-axis varies across states because the state-level price aggregates over event mix (e.g., parlays vs. straight bets) and sportsbook market shares, both of which vary by state. Panels (b) and (c): theoretical price per dollar wagered around New York's January 2022 launch for FanDuel and DraftKings. Each point is the weekly mean across NBA games, with point size proportional to the number of games. Solid lines show pre- and post-launch interrupted time series (ITS) fits; the dashed black line shows what prices would be if sportsbooks raised prices enough so that they would have the same post-tax margin as before i.e. if the entire incidence were on consumers. The ITS model is $p_t = \beta_0 + \beta_1 t + \beta_2\,\text{Post}_t + \beta_3(t \times \text{Post}_t) + \epsilon_t$, where $\text{Post}_t = 1$ after January 8, 2022. β_2 is the level change at the cutoff. Standard errors use the Newey-West estimator with 7 lags.

within a fiscal year, and $0.50 on all remaining online wagers [Illinois Gaming Board, 2025]. This tax is not a specific tax, because it is assessed per transaction rather than per dollar wagered. But like a specific tax, and unlike an ad valorem tax, this tax raises marginal cost per dollar wagered, so our model predicts it should pass through to price. The average tax paid from July 2025 through March 2026 was 0.81¢ per dollar wagered.[9]

Every major sportsbook responded to the tax by either increasing consumer fees or limiting small bets (Table A5).[10] FanDuel, Caesars, and Fanatics pass through the full fee on every online wager. DraftKings and bet365 pass through the fee only on smaller wagers. For example, DraftKings applies the fee to straight bets (bets on a single outcome) $\leq$ \$50, and to parlays $<$ \$10. BetMGM and BetRivers raised minimum bet sizes instead of passing through a fee, equivalent to an infinite tax on small bets. Figure 3 shows how DraftKings and FanDuel described their fees to consumers. Both firms emphasize in their messaging that these price increases are the direct result of the Illinois tax. These facts demonstrate that firms are technically capable of setting state-specific fees, but they choose not to do so in response to ad valorem tax rates. Positive pass-through of the per-wager tax is qualitatively consistent with Section 3's model.

Besides Illinois, Tennessee is the only state with a tax base other than sportsbook revenue. Tennessee assesses a 1.85 cent specific tax per dollar wagered, but no sportsbook posts different odds or fees there. This contradicts the model's prediction that a specific tax is passed through. The Tennessee specific tax represented a net cut from an earlier tax regime, which resulted in an effective rate of at least 2 cents per dollar wagered.[11] Legibility and fairness, both outside our stylized model, may explain why firms responded differently in Tennessee versus Illinois. The Illinois tax is very clear to explain to bettors: a flat per-bet fee that firms can show and attribute to the state. The Illinois tax was an *increase*, so passing it through may be perceived as fair. The Tennessee tax was a net cut, so raising prices might have invited regulatory retaliation.

5.3 Discussion

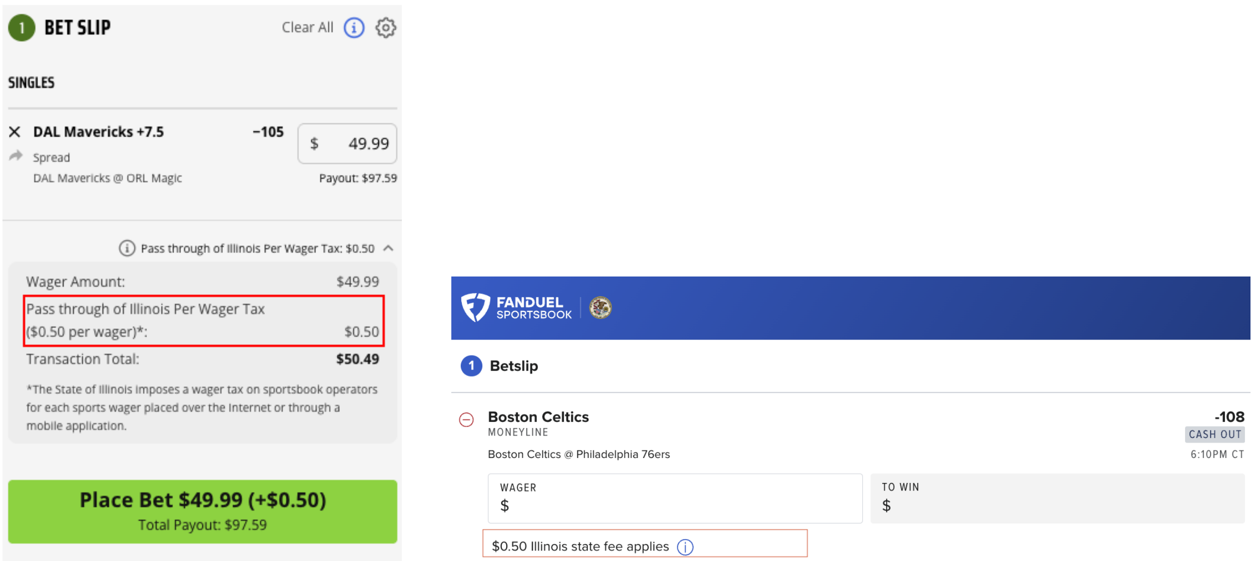
Consistent with our model, sportsbooks do not vary prices in response to the ad valorem tax rate. This finding does not distinguish between sportsbooks profit-maximizing as in our stylized model, and merely facing an unmodeled constraint to price uniformly (as in DellaVigna and Gentzkow 2019). But the pass-through of a per-wager tax in Illinois at least rules out that firms face infinite costs of deviating from uniform pricing. More broadly, Figure

[9] The tax raised $94.5 million on $11.68 billion of dollars wagered online.

[10] No sportsbook adjusted odds in response, consistent with the uniform-pricing evidence in Section 5.1.

[11] It replaced a 20% ad valorem tax which was paired with a 10% minimum price.

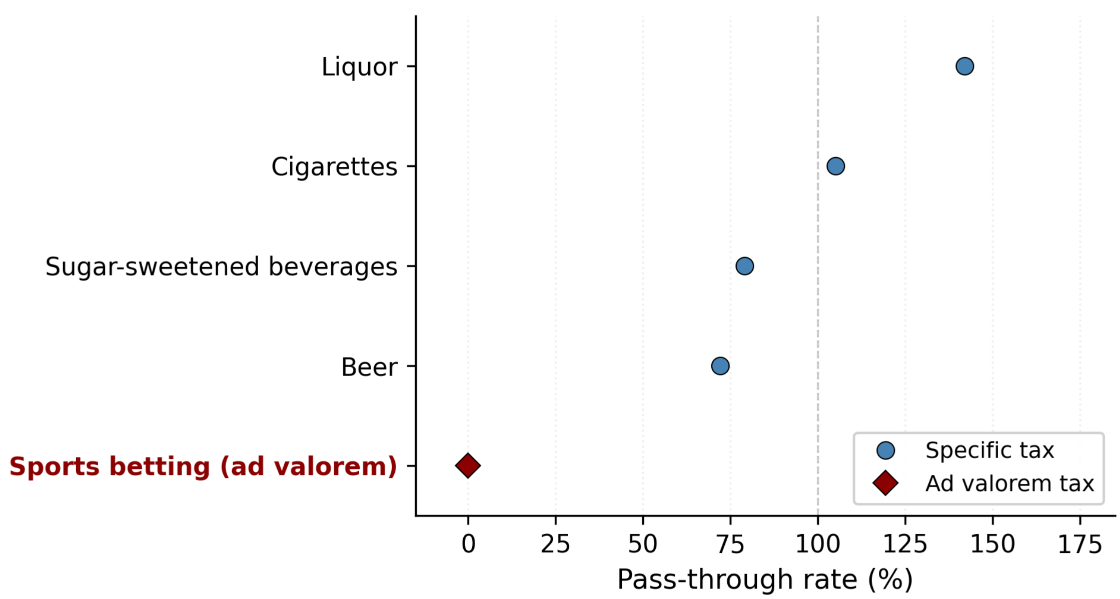
Figure 3: Pass-Through of a Local Per-Wager Tax



(a) DraftKings ($49.99 wager) **(b)** FanDuel

Notes: Panel (a) shows DraftKings adding a $0.50 Illinois state fee to a $49.99 wager. Panel (b) shows FanDuel displaying the Illinois fee on the bet slip. The DraftKings screenshot file was captured March 6, 2026, and the FanDuel screenshot file was captured December 18, 2025. Both screenshots reflect the Illinois per-wager tax after the surcharges were rolled out on September 1, 2025. For DraftKings, the per-wager fee applies only to straight bets of $50 or less and parlays under $10.

Figure 4: Pass-through rates of specific taxes and the ad valorem tax on sports betting



Notes: Specific excise tax pass-through estimates are from Butters et al. [2023], Table 5. For the sportsbook ad valorem tax, we define pass-through as $\rho_\tau = d \log p / d \log(1+\tau)$, as is common in the literature (see, e.g. [Kroft et al., 2024]).

4 shows that the sports betting ad valorem tax is an anomaly among taxes on consumer products with unpriced harms. Full pass-through or even overshifting of the tax (pass-through greater than 100%) is common [Butters et al., 2023]. Sports betting ad valorem taxes thus do not create deadweight loss from price changes, but also cannot have corrective effects by increasing prices. In the next section, we explore whether they distort advertising.

5.4 Effects on Local Marketing Expenditures

We begin by documenting narrative evidence that firms reduced marketing expenditure in response to high ad valorem tax rates. In a 2022 investor day, BetMGM's holding firm (Entain) described a strategy of diverting its marketing budget towards states with low ad valorem taxes [Entain Group, 2022]:

> During Q1 [2022], BetMGM made a concerted decision to pull back in our pursuit of players in New York due to its unfavourable tax environment. This reduced revenue slightly. However, marketing budget was diverted from New York to states with better economic returns. And this helped drive acquisition overperformance in those states.

BetMGM's statement is representative of statements from other sportsbooks about tax rates and marketing across jurisdictions. We collect several examples in Table 1.

We next quantify the cross-sectional association between local ad valorem tax rates and two forms of local marketing expenditure: TV advertising and the generosity of promotional offers. To do this, we collect data on local marketing expenditures at the sportsbook-state level, and regress marketing expenditures on local state taxes and sportsbook fixed effects. Our estimating equation for local TV advertisements is

$$\text{AdSpend}_{sbt} = \lambda_{bt} + \delta^{Ads} \cdot \tau_s + \nu_{sbt} \tag{3}$$

where $AdSpend_{sbt}$ is local TV ad spending per 100 residents for sportsbook b in state s in year t. We have multiple years of local advertising data, so we include sportsbook-year fixed effects in Equation (3). Local advertising is measured at the DMA level, which can cross state borders. We drop DMAs crossing state borders, which represent 65.4% of legal states' population; Table B1 includes further detail on these dropped DMAs. The estimating equation for promotional offers is similar:

$$\text{Promo}_{sb} = \alpha_b + \delta^{Promo} \cdot \tau_s + \epsilon_{sb} \tag{4}$$

Table 1: Industry statements on marketing responses to tax rates

Sportsbook	Quote	Source
Penn	"We've been very disciplined on the promo side. The tax rate is extremely high [in NY] at over 50%, and you don't have any promo deduction opportunity before you pay taxes."	Q3 2024 earnings call [Penn Entertainment, 2024]
FanDuel	"During Q2, the Illinois Gaming Board announced an increase in gaming taxes which became effective from July 1, 2024. We expect to directly mitigate 50% of the cost in 2025 through locally optimized promotional and marketing spend."	Q2 2024 earnings release [Flutter Entertainment, 2024]
BetMGM	"During Q1 [2022], BetMGM made a concerted decision to pull back in our pursuit of players in New York due to its unfavourable tax environment. This reduced revenue slightly. However, marketing budget was diverted from New York to states with better economic returns. And this helped drive acquisition overperformance in those states."	May 2022 investor day [Entain Group, 2022]
DraftKings	"We have made significant progress identifying customers with lower lifetime values, especially in high tax states. A high tax state is defined as a state that has multiple sports betting operators and a tax rate above 20%."	Q3 2024 investor relations [DraftKings, 2024b]

where Promo_{sb} is the expected value of the sign-up offer from sportsbook b in state s and τ_s is the ad valorem tax in state s. We compute these expected values using conventions established by DarkHorse Odds, a service that helps users take advantage of promotional offers. The expected values of sign-up offers range from the low hundreds to over a thousand dollars, as shown in Table A3. In both regressions, the coefficient δ captures the association between local ad valorem taxes and local marketing, within a sportsbook across states. We must rely on cross-sectional variation because our advertising data ends in 2023; every within-state tax change is either within a year of legalization (Ohio) or after our advertising data ends (Appendix Table A7).

Figure 5 illustrates our results by plotting residualized marketing expenditures against residualized taxes. Consistent with our narrative evidence, ad valorem tax rates are negatively associated with both measures of marketing expenditure. A 10 p.p. increase in the ad valorem tax rate is associated with a \$5.54 (19% of the mean across state-sportsbooks) reduction in local TV ads per 100 residents ($p = 0.0209$) and a \$77 (13% of the mean across state-sportsbooks) decrease in the expected value of sign-up offers ($p = 0.06$).

Both correlations remain significant when controlling for the number of large sportsbooks in the state (a measure of competition) and years since the state legalized sports betting (Table A6). We include the latter control because states tend to have a large ad surge immediately after legalizing. We are not powered to detect effects with more controls: the coefficient on tax rate loses significance once we control for income and Democratic vote share, though it remains negative. As another robustness check, Figure A4 contains a leave-one-state-out exercise, dropping the three highest-tax states one-by-one. The result is qualitatively similar in each.

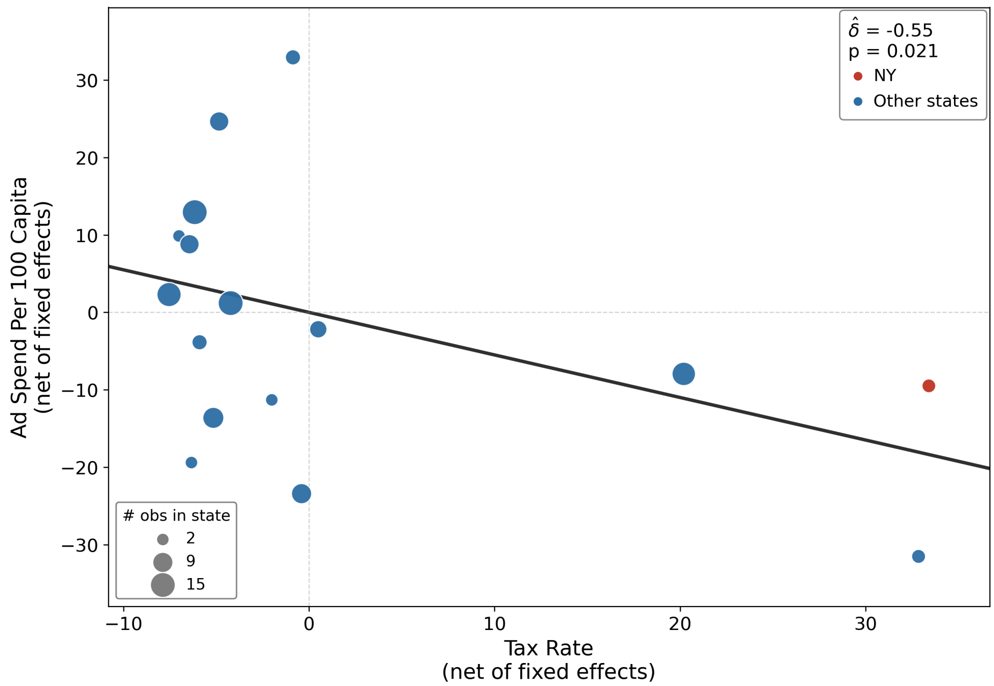
Discussion.

Our results on marketing are consistent with the model in Section 3 in which a higher ad valorem tax rate reduces optimal advertising. The efficiency of ad valorem taxes thus depends on how marketing affects sports betting demand. The next section estimates how sportsbook deposits respond to local TV advertising.

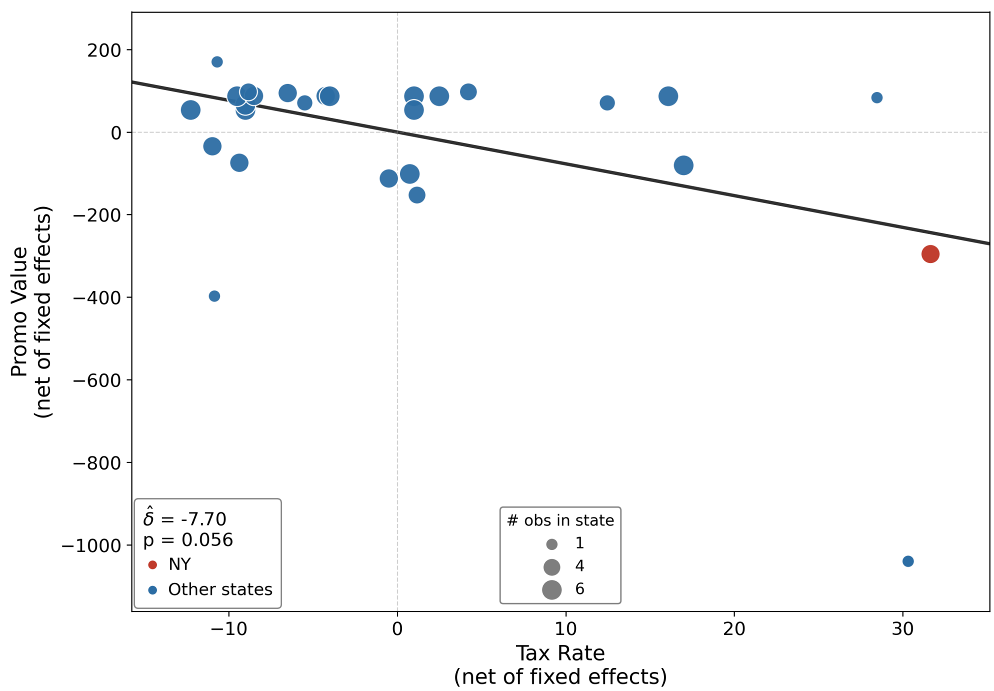
6 The Effect of Sportsbook Marketing on Demand

This section estimates the relationship between sports betting marketing and sports betting demand. We focus on local TV advertising throughout.

Figure 5: Relationship between state tax rates and marketing activity



(a) Local TV ad spending



(b) Promotional generosity

Notes: Each dot is a state, with size proportional to the number of underlying observations. Both axes are residualized on the regression's fixed effects. Red points are New York. Panel (a) plots local TV ad spending per 100 residents against ad valorem tax rates, averaged across sportsbook-years, residualized on sportsbook × year fixed effects. Local TV ad spending covers 2019–2023 from 5 large sportsbooks. N = 115 state-sportsbook-year observations across 16 states. Panel (b) plots promotional generosity against ad valorem tax rates, averaged across sportsbooks, residualized on sportsbook fixed effects. This analysis uses 6 sportsbooks: Bet365, BetMGM, BetRivers, DraftKings, FanDuel, Fanatics, which collectively represent 86.4% of national dollars wagered. Caesars offers uniform promos across all states and is excluded. N = 124 state-sportsbook pairs across 28 states. p-values from wild cluster bootstrap, clustered by state for both panels. Appendix B.1.1 contains sample selection details.

6.1 Empirical Strategy

A simple regression of sports betting consumption on advertising would suffer from standard endogeneity problems: firms likely target advertising to where demand is high. To isolate quasi-random variation in advertising, we implement a border design in the spirit of Shapiro [2018]. Nielsen divides the U.S. into 210 Designated Market Areas (DMAs), and a household's DMA determines which local TV ads it sees. As an example, we illustrate the border between New York City's DMA and the Philadelphia DMA, which bisects New Jersey, in Figure A5. We estimate the impact of advertising on demand by measuring how deposits and advertising co-vary over time on each side of a DMA "border experiment."

We implement this design using the exact specification from Shapiro [2018]:

$$\begin{aligned}\ln Y_{jmt} = \lambda \ln Y_{jm,t-1} + \gamma_1 a^{\text{own}}_{jmt} + \gamma_2 a^{\text{rival}}_{jmt} + \gamma_3 (a^{\text{own}}_{jmt})^2 \\ + \gamma_4 (a^{\text{rival}}_{jmt})^2 + \gamma_5 a^{\text{own}}_{jmt} a^{\text{rival}}_{jmt} + \alpha_{jbm} + \alpha_{jbq} + \varepsilon_{jmt}\end{aligned} \quad (5)$$

where j indexes sportsbooks, m indexes DMAs, t indexes months, and b indexes border experiments. For most of our specifications, the outcome Y_{jmt} will be deposits at a sportsbook in a DMA-month. a^{own}_{jmt} is sportsbook j's own advertising (\$/100 capita in the DMA), and a^{rival}_{jmt} is the sum of all other sportsbooks' ("rival") advertising. Quadratic and interaction effects allow for the possibility that advertising has diminishing marginal returns. The lagged term, $Y_{jm,t-1}$, controls for persistence in sports betting demand.[12] The sportsbook $\times$ border $\times$ DMA fixed effects and sportsbook $\times$ border $\times$ quarter fixed effects absorb permanent differences between sides of a border and time-varying shocks common to both sides of a border respectively.

Because of the fixed effects, our estimates are identified from within-border experiment, within-quarter variation: one side of the border receives more advertising than the other in a given month, relative to the border-quarter average. To interpret our estimates causally, we assume that households on either side of the border would have behaved similarly absent such an advertising shock. Two institutional details of the local TV advertising market minimize threats to this assumption, as discussed in Shapiro et al. [2021]. First, local TV ads are usually bought several months ahead of airing, making it difficult to *time* advertisements to coincide with local demand shocks. Second, local TV ads are often bought in bulk, making

[12] The lagged dependent variable with fixed effects induces downward bias in $\hat{\lambda}$ in a finite panel [Nickell, 1981]. The asymptotic ($N \to \infty$) bias is $\operatorname{plim}(\hat{\lambda} - \lambda) = \left\{ \frac{2\lambda}{1-\lambda^2} - \left[\frac{1+\lambda}{T-1} \left(1 - \frac{1}{T} \frac{1-\lambda^T}{1-\lambda} \right) \right]^{-1} \right\}^{-1} \approx \frac{-(1+\lambda)}{T-1}$. With $T = 63$ months and $\hat{\lambda} = 0.35$, the exact bias is -0.0217, or 6.1% of $\hat{\lambda}$. Re-estimating column (1) on the same sample without the lagged outcome gives $\hat{\gamma}_1 = 0.0234$ (SE 0.0051) and $\hat{\gamma}_2 = 0.0200$ (SE 0.0034), statistically indistinguishable from the with-lag estimates of 0.0207 and 0.0179.

it difficult to *locate* advertisements in specific markets.

Estimates from specification (5) represent contemporaneous responses to advertisements. To the extent that advertisements have impacts on consumption beyond a one-month time horizon, our estimates will understate the overall effect of advertisements on consumption. The advertising literature generally concludes that long-run elasticities exceed short-run elasticities [Sethuraman et al., 2011, Shapiro et al., 2021]; habit formation may make long-run impacts particularly important in the gambling context [Guryan and Kearney, 2010]. A related concern is that advertisements may merely retime demand instead of increasing it. To test for retiming, we run specifications that include one-month lags of own and rival advertising. Retiming would imply that lagged advertising has a negative effect on today's deposits. In fact, coefficients on lagged advertising are either positive or not statistically significant, suggesting retiming is not a major concern (Table A12).

We impose two sample restrictions when taking this design to the data. First, to avoid confounds from changes in state-specific regulations over time, such as tax rates, we restrict all border experiments to be within-states.[13] Second, we restrict to households that we can confidently locate within a given DMA, because the underlying household geography variable is at the ZIP3 level, and ZIP3s do not perfectly align with DMA boundaries. In our preferred specification, we assign each ZIP3 to the DMA containing at least 80% of its area, and drop ZIP3s which do not have 80% of their area in any DMA. After applying these restrictions, our preferred specification uses 135 border experiments. We show in Figure A6 that results are stable as we vary this 80% threshold. We provide further details on sample construction in Appendix B.1.2.

Our outcome is logged; we also include a lag of this outcome on the right-hand side. We drop observations where either the outcome or its lag is zero. Methods designed to accommodate zeros in the outcome, such as Poisson pseudo-maximum likelihood [Santos Silva and Tenreyro, 2006], do not accommodate zeros on the right-hand side, and would thus require dropping nearly the same observations as the ones we drop. We do not apply a log-like transformation such as $\log(1+Y)$, since these transformations depend on how units of the outcome are defined and cannot be interpreted as percentage effects [Chen and Roth, 2024].

Dropping zeros removes 36.9% of observations in our main specification. Two heuristic tests suggest that dropping zeros does not upwardly bias our estimates. First, Table A14 restricts the sample to the two largest sportsbooks, DraftKings and FanDuel, where zeros are much less prevalent: only 10.0% of observations are dropped. If the method we used to drop zeros was biasing our results, that bias should be smaller in a sample with fewer zeros. All coefficients are similar in magnitude when we restrict to this sample. Second,

[13] Results are qualitatively robust to allowing cross-state border experiments (Table A13).

the dropped observations have significantly lower advertising than the observations in our sample, conditional on the fixed effects in our regression ($p < 0.001$). We find a positive effect of advertising on deposits despite dropping observations with both low ads and zero deposits, suggesting that, if anything, our estimates are attenuated.

6.2 Contemporaneous Effects of Advertising

Table 2: Effects of Advertising on Sports Betting Deposits

		Customers		Dep./Customer	
	Deposits	New	Existing	New	Existing
	(1)	(2)	(3)	(4)	(5)
$\ln Y_{j,m,t-1}$	0.35323***	0.14271***	0.40986***	−0.13968***	0.26953***
	(0.02447)	(0.02368)	(0.02652)	(0.01749)	(0.02634)
Own	0.02090***	0.05161***	0.02403***	−0.00582	−0.00062
	(0.00465)	(0.00704)	(0.00322)	(0.00699)	(0.00387)
Rival	0.01813***	0.02727***	0.01614***	−0.00184	0.00306
	(0.00300)	(0.00332)	(0.00311)	(0.00376)	(0.00293)
Own^2	−0.00036***	−0.00103***	−0.00039***	0.00020	0.00009
	(0.00012)	(0.00019)	(0.00007)	(0.00015)	(0.00009)
Rival^2	−0.00020***	−0.00027***	−0.00022***	0.00008	−0.00002
	(0.00006)	(0.00007)	(0.00007)	(0.00006)	(0.00005)
Own × Rival	0.00002	0.00000	−0.00001	−0.00011	−0.00009
	(0.00017)	(0.00016)	(0.00014)	(0.00019)	(0.00015)
SB × Border × DMA FE	Yes	Yes	Yes	Yes	Yes
SB × Border × Quarter FE	Yes	Yes	Yes	Yes	Yes
Observations	12,850	12,850	12,850	12,850	12,850
R^2	0.938	0.868	0.965	0.518	0.805

Notes: Sportsbook × DMA clustered standard errors in parentheses. $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. Column (1) pools all depositors. Columns (2)–(5): "New" = first deposit at that sportsbook in that calendar month. Border experiments restricted to quarters in which sports betting is legal and to ZIP3s where a majority of the population resides in one state. This table uses Consumer Edge data.

We find that advertising increases sportsbook deposits. Column (1) of Table 2 reports the relevant estimates. The coefficient on own advertising indicates that a $1 per 100 residents increase in monthly local TV advertising increases deposits by approximately 2.1%. The coefficient on rivals' advertising is similar in magnitude to that on own advertising, suggesting that local TV advertising primarily impacts demand through market expansion, rather than business stealing. These magnitudes are similar to those found in Shapiro [2018] for antidepressant prescriptions and to those in Shapiro et al. [2021] for consumer-packaged goods.

To understand how ad valorem tax rates affect deposits, we can combine the causal effect of ads on deposits and the association between tax rates and ads. Treating the latter association as causal, we find a 1 percentage point increase in ad valorem tax rates would reduce deposits by 0.25% through reduced local TV advertising (see Table A8). This semi-elasticity implies an elasticity of consumer deposits with respect to the tax rate of -0.053, at the prevailing revenue-weighted average tax rate of 21%.

The effect of taxes on deposits through the advertising channel suggests a reduced-form relationship: dollars wagered should be lower in high-tax states. In a bivariate correlation, the sign and magnitude are similar to what we find by chaining our estimates above. A 1 p.p. higher ad valorem tax rate is associated with $7.92 lower 2024 dollars wagered per capita (1.08% of the cross-state mean), $p = 0.154$. We plot this association in Figure A7.

6.3 Mechanisms of Sports Betting Ads

We next turn to the mechanisms by which advertising impacts deposits. In columns (2) through (5) of Table 2, we decompose the effect of advertising into the extensive margin (the chance of a household making any deposit) and the intensive margin (the amount deposited, conditional on making at least one deposit). To understand whether ads attract new customers versus increase deposits by existing ones, we also split cards according to whether they have ever made a deposit at the sportsbook in the past, and estimate (5) for each sub-sample.

We find that advertising primarily works through the extensive margin. We estimate a precise null on the intensive margin (dollars per customer) and can rule out an intensive margin semi-elasticity larger than 0.8%, much smaller than the total effect of 2.1%. The effects of advertising are proportionally larger for new customers: the own-ads extensive margin coefficient is more than twice as large for new customers as for existing customers. These findings are broadly consistent with other results in the advertising literature. On the extensive vs. intensive margin, Bertrand et al. [2010] find that advertising influences take-up but not the amount of consumer loans. On new vs. existing consumers, Blake et al. [2015] find that new and infrequent users are positively influenced by ads, but that most advertising is spent on frequent users, for whom advertising is not effective.

While the analysis above exclusively studies the impact of TV advertisements, in Appendix A.5, we conduct a similar analysis to measure the impacts of promotional sign-up offers on sports betting demand. Our point estimates indicate that promotional offers increase the chance of a deposit, especially for new customers, but these estimates are imprecise (Figure A9).

6.4 Dynamics of sports betting and characteristics of marginal bettors

Our above estimates only look at the contemporaneous effects of advertisements. Now we explore the dynamics of sports betting over time for people who were exposed to higher levels of plausibly exogenous variation in advertising at sign-up. Understanding who these consumers are is important because the welfare effects of a reduction in ads (either through taxes or regulation) depend on whether marginal bettors are casual bettors or bettors with self-control or misperception problems.

We examine two types of outcomes for depositors: (i) the share of depositors who make a deposit at $t = 1 \ldots 6$ months after their first deposit and (ii) average monthly dollars deposited, including those who make no deposits.

Before exploring heterogeneity, we see that most people do not keep depositing after making their initial deposit. Figure 6a shows that only 34% of new depositors to a sportsbook make a deposit in the next month, and only 13% make a deposit in each of the six subsequent months. Figure 6c shows this drop-off in dollar terms, combining the intensive and extensive margin. A depositor's first month tends to be their highest deposit-month. Average monthly deposits decline from \$441 to \$164 six months after the month of their deposit. Of all dollars deposited over a depositor's first 7 months, 30% comes in month one.

To get at the characteristics of marginal bettors, we compare people who first deposited in high vs. low advertising months. The difference is informative about the characteristics of bettors marginal to advertising.

To ensure our measure of advertising is plausibly exogenous, we residualize using the same fixed effects and sample as Equation (5). We residualize out sportsbook $\times$ border $\times$ side ($\hat{\alpha}_{jbm(z)}$) and sportsbook $\times$ border $\times$ quarter fixed effects ($\hat{\alpha}_{jbq}$), leaving a residual $\tilde{a}^{\text{own}}_{jzbt}$ that is defined separately for each border experiment b:

$$\tilde{a}^{\text{own}}_{jzbt} = a^{\text{own}}_{jm(z)t} - \hat{\alpha}_{jbm(z)} - \hat{\alpha}_{jbq} \tag{6}$$

where $m(z)$ is the DMA containing ZIP3 z. The residual $\tilde{a}^{\text{own}}_{jzbt}$ is plausibly exogenous by the same argument as the identifying variation in Equation (5). Because a ZIP3 can belong to multiple border experiments, we average these residuals across border experiments, to give each sportsbook–ZIP3–month a single value, $\tilde{a}^{\text{own}}_{jzt}$.

Since a person can deposit at multiple sportsbooks, the unit of analysis is the depositor-sportsbook pair. We split the entire sample of depositor-sportsbooks in half based on the level of $\tilde{a}^{\text{own}}_{jzt}$ in that depositor's ZIP3 (z) in the month (t) of their first deposit to that sportsbook (j). We call these *the high-ad and low-ad groups.*

New depositor-sportsbook pairs in the high-ad group made their first deposit in periods when that sportsbook's ads were, on average, 2.6 times higher than for new depositors to that sportsbook in the low-ad group. Figure 6 compares outcomes for the high-ad and low-ad groups. The two groups are similar in sportsbook composition and cohort-year composition (when they first deposited). Table A11 provides more detail on the groups' composition.

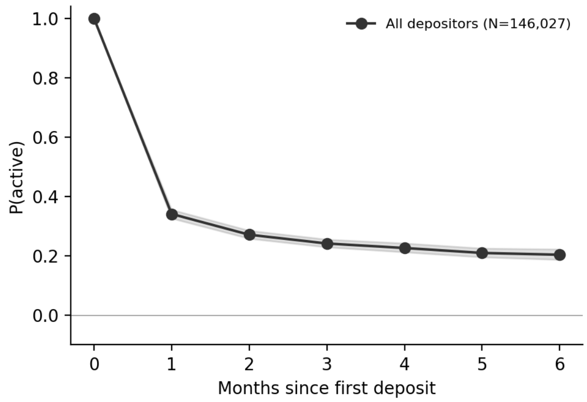
We find no evidence that high-$\tilde{a}^{\text{own}}$ periods bring in customers who go on to deposit at disproportionately high levels. We find that the high-ad group does not deposit more in their first month than the low-ad group, consistent with the intensive margin analysis in Table 2. This pattern persists in their first several months of activity. By month 6, our 95% confidence interval rules out that the difference between the high-ad and low-ad groups is larger than $19 dollars per month per depositor-sportsbook. We can also rule out that the high-ad group is meaningfully more likely to remain active six months after their first deposit; at the upper end of our 95% confidence interval, this difference is 0.03 p.p. In fact, our point estimate suggests the high-ad group is 2.4 p.p. *less* likely to be active six months later, though this difference is not statistically significant.

These results have implications for the design of sports betting policy. We show in Section 5 that the main consequence of ad valorem taxes is to reduce sportsbook marketing. The SAFE Bet Act, a federal bill introduced in 2025, but not yet passed, would regulate sports betting advertising, with an explicit goal to mitigate harms from problem gambling [Tonko, 2025]. Our results suggest that policies restricting advertising would be an effective but blunt tool to accomplish this goal: we do not find evidence that advertising disproportionately brings high-deposit customers into the market.

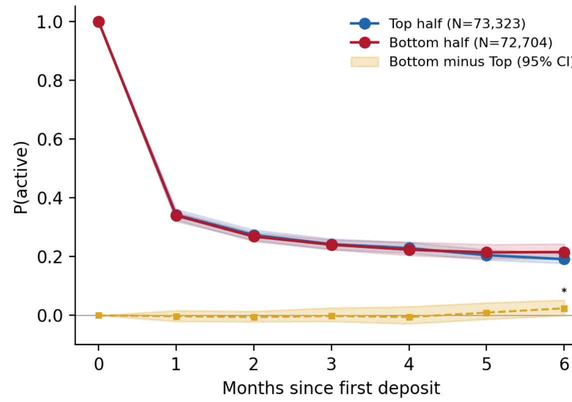
7 Quantitative Comparison of Tax Designs

The empirical analysis above has provided novel evidence on the positive consequences of ad valorem taxation in sports betting. We now turn to the incidence and efficiency of sports betting taxes, focusing on a comparison between the existing ad valorem tax and a natural alternative, a specific unit tax on dollars wagered. We do this by specializing the model from Section 3 and calibrating relevant parameters.

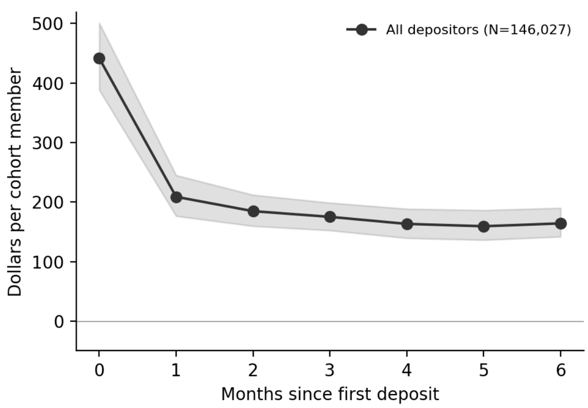
Figure 6: Dynamics of sports betting deposits, by ad-exposure in month of first deposit



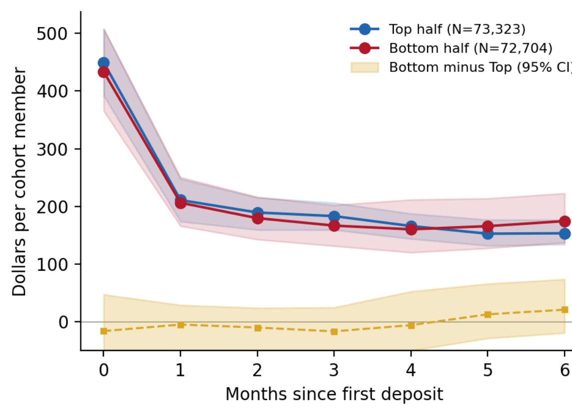
(a) Retention rate (all depositors)



(b) Retention rate by ad intensity



(c) Monthly dollars deposited per new depositor



(d) Monthly dollars deposited per new depositor by ad intensity

Notes: The left column pools all depositors across ad intensity. The right column compares above- vs. below-median residualized own-advertising intensity in the month of first deposit. Stars denote two-sided p-values (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$) from the bootstrap distribution constructed by resampling DMA × sportsbook blocks (all ZIP3s and time periods in that block) with replacement. Shaded bands show 95% bootstrap confidence intervals. This figure uses Consumer Edge data.

7.1 Framework

We are interested in *efficiency*, which we measure with the total burden across consumers and firms per dollar of revenue raised, and *incidence*, which we measure with the relative burden on consumers vs. sportsbooks. Social planners that place different welfare weights on consumers versus firms will generally be interested in both efficiency and incidence.

To conduct this welfare analysis, we need to make further assumptions. We use as a foundation the stylized model from Section 3 where firms choose advertising and prices in symmetric imperfect competition, and there are zero marginal costs for offering a dollar wagered. Consistent with our empirical evidence, we maintain the positive predictions of this model, including zero pass through of ad valorem taxes to prices.

We make four additional assumptions that allow us to characterize the welfare effects of taxes. The first is a quasilinear utility assumption to guarantee that consumer surplus is well-defined.

Assumption 1: Quasilinear utility. *Let i index consumers. Each consumer in the market has a utility function of the form $U(Q, y) = v_i(Q) + (y - pQ)$, where Q is dollars wagered, all money not spent on gambling is spent on a numeraire good, and y is an endowment. The utility from gambling function v_i is increasing and concave for all consumers.*

With this assumption, we can measure aggregate *decision consumer surplus* from gambling in dollar units as the area between the market demand curve and the price of betting.

In the gambling context, decision consumer surplus may not capture all the welfare effects of gambling consumption. There may be externalities (like harms borne by non-betting members of the household) or internalities (like misperceptions of financial costs). We account for uninternalized harms with a single distortion parameter.

Assumption 2: Homogeneous price-metric distortion ζ. *The total uninternalized harms from betting, including internalities and externalities, are $\zeta \cdot Q$.*

The third assumption concerns the shape of the market demand curve. We choose a constant semi-elasticity functional form, which allows us to directly import a price-sensitivity estimate from Brown et al. [2025].

Assumption 3: Constant semi-elasticity of demand. *The market demand curve takes the following form: $Q(p) = c\, e^{-p \cdot s^D_{Q,P}}$ (where $s^D_{Q,P}$ is the own-price semi-elasticity of demand).*

In standard analyses of marginal tax burdens, the shape of the demand curve away from the margin is irrelevant and only local elasticities matter. The only place where the functional form chosen in Assumption 3 affects our results is when we consider the welfare effects of advertisements. Our fourth assumption concerns this issue.

The welfare effects of advertisements depend on the mechanism by which ads induce consumption. There is no standard approach to this issue in the literature. Our main approach follows models of informative advertising, especially Butters [1977]. We assume that the industry-wide level of advertising A determines the share of consumers $g(A)$ who are aware of the opportunity to consume ($g(A)$ is increasing in A). The complementary share $1 - g(A)$ never consume. Conditional on awareness or unawareness, the level of advertising does not affect consumer welfare in this model, which distinguishes our model from models in which advertising enters directly into utility like Becker and Murphy [1993]. We consider sensitivity to alternative normative assumptions while presenting results.

Under this model, the welfare effects of ad-induced consumption can differ sharply from the welfare effects of price-induced consumption. Consumption units that are marginal to a price change provide zero decision consumer surplus (by the envelope theorem), but consumption units that are marginal to advertising yield positive surplus. As a base case, consider the simple benchmark of randomly targeted ads. In that case, the average decision consumer surplus per ad-induced consumption unit is equal to the average decision consumer surplus per consumption unit in the rest of the market. With our chosen functional form, average decision consumer surplus per unit is the inverse of the price semi-elasticity, $1/s^D_{Q,P}$.[14] We use this assumption as our base case.

Assumption 4: Randomly targeted advertisements with no direct welfare effects. *For every unit of consumption that is induced by marginally higher advertising, decision consumer surplus rises by* $1/s^D_{Q,P}$.

In support of our assumption, we have suggestive evidence that ad-induced bettors are not especially selected on willingness-to-pay. Plausibly exogenous ad exposure in the month a depositor first deposits ($\tilde{a}^{\text{own}}_{jzt}$) has close to zero correlation with both the share making a deposit at month 6 ($\rho = -0.09$, $p = 0.06$) and cumulative deposits over the first six months ($\rho = -0.02$, $p = 0.69$), consistent with Figure 6.[15]

Under these assumptions, we can characterize the welfare effects of a marginal tax increase in terms of parameters that we can estimate or calibrate. The first set of parameters are reduced-form "tax semi-elasticities." We define η^{Tot}_j as the total semi-elasticity of quantity with respect to tax j – that is, when tax instrument j rises by one unit, gambling consumption

[14] Total decision consumer surplus above price p^* is $\int_{p^*}^{\infty} Q_0\, e^{-s^D_{Q,P}(p-p^*)}\, dp = Q_0/s^D_{Q,P}$, so average CS per unit is $1/s^D_{Q,P}$.

[15] Our approach amounts to assuming that sports bettors crowded in by advertisements derive as much decision consumer surplus for gambling as other bettors. If our assumption is wrong, and ad-marginal consumers have lower WTP, we overstate the welfare costs of a reduction in advertisements. See Section III of Becker and Murphy [1993] for an argument that ads primarily bring in marginal consumers. The opposite case, ads bringing in consumers with higher WTP than current consumers, seems less likely. Such consumers would likely learn about the product regardless of whether they see the ad.

falls by $\eta_j^{Tot}\%$.[16] The index j indicates either the specific tax t or the ad valorem tax τ. Since the welfare effects of ad-induced consumption differ from the welfare effects of price-induced consumption, we decompose η_j^{Tot} into an ad channel and a price channel: $\eta_j^{Tot} = \eta_j^A + \eta_j^P$, where $\eta_j^A = -\frac{1}{Q}\frac{\partial Q}{\partial A}\frac{dA}{dj}$ allows ads to change while prices are fixed, and $\eta_j^P = -\frac{1}{Q}\frac{\partial Q}{\partial P}\frac{dP}{dj}$ allows prices to change while ads are fixed. Aside from these tax semi-elasticities, we also define the revenue raised per unit at the existing tax regime, z_j, and the firm's producer surplus on a marginal unit, net of taxes, $m = p - \kappa - z_j$. These terms govern the extent to which a marginal reduction in dollars wagered reduces firm profits and government revenue respectively. Finally, we let ω_j denote the "mechanical" impact of a tax on revenues, ignoring behavioral responses ($\omega_\tau = p$, $\omega_t = 1$), and use $\frac{dp}{dj}$ to denote the effect of tax j on consumer prices.

Proposition 2 uses these parameters to characterize the efficiency and incidence of a tax in units of surplus change per dollar of revenue raised.

Proposition 2. *Under assumptions 1 through 4, the ratios of surplus effects to revenue raised from a marginal increase in tax instrument j are given by the following expressions. The first three expressions give changes in disaggregated surplus components; the final expression gives the marginal excess burden, for which the numerator is the change in total surplus.*

1. *Decision consumer surplus:*

$$\frac{-\frac{dp}{dj} - \frac{1}{s^D_{Q,P}} \cdot \eta_j^A}{\omega_j - z_j \cdot \eta_j^{Tot}} \tag{7}$$

2. *Producer surplus:*

$$\frac{(\frac{dp}{dj} - \omega_j) - m \cdot \eta_j^P}{\omega_j - z_j \cdot \eta_j^{Tot}} \tag{8}$$

3. *Externalities and internalities:*

$$\frac{\zeta \cdot \eta_j^{Tot}}{\omega_j - z_j \cdot \eta_j^{Tot}} \tag{9}$$

[16] Our sign convention is that all semi-elasticities are positive, even though consumption falls in response to tax increases.

4. Marginal Excess Burden

$$\frac{\overbrace{-z_j \cdot \eta_j^{Tot}}^{\text{Base Erosion}} - \overbrace{\frac{1}{s_{Q,P}^D} \cdot \eta_j^A}^{\substack{\text{Decision consumer surplus loss} \\ \text{(through ads channel)}}} - \overbrace{m \cdot \eta_j^P}^{\substack{\text{Lost profits} \\ \text{(through price channel)}}} + \overbrace{\zeta \cdot \eta_j^{Tot}}^{\text{Corrective Effects}}}{\underbrace{\omega_j}_{\text{Mechanical Revenue}} - \underbrace{z_j \cdot \eta_j^{Tot}}_{\text{Base Erosion}}} \tag{10}$$

Appendix C.4 provides a proof.

The MEB expression in equation (10) includes a standard excess burden term and three terms specific to our setting. In perfect competition with no externalities, the typical Harberger calculation gives an MEB of $\frac{-z_j \cdot \eta_j^{Tot}}{\omega_j - z_j \cdot \eta_j^{Tot}}$ for either tax instrument – the tax creates deadweight loss to the extent that it reduces quantities, through any channel. This term appears in our equation (10). The standard result that the incidence of a tax depends on its impact on prices also carries through in our setting for both taxes, as $\frac{dp}{dj}$ appears negatively in the decision consumer surplus equation (7) and positively in the producer surplus equation (8). As usual, these price effects do not appear in the MEB equation because they represent transfers that cancel when summing surplus components. Our setting then involves three additional first-order welfare effects from quantity changes. First, for any ad-induced quantity changes, decision consumer surplus falls by $1/s_{Q,P}^D$ (per Assumption 4).[17] Second, for any price-induced quantity changes, producer surplus falls by m.[18] Third, if gambling causes externalities or internalities, the tax has corrective benefits. For quantity changes through either channel, uninternalized harms are reduced by ζ per unit.

We now turn to a quantitative analysis of the welfare effects of taxes. We begin by calibrating several parameters: demand and ad elasticities, marginal costs, and uninternalized harms.

7.2 Calibration

We summarize our calibrated primitives and key derived parameters in Table 3. Panel A reports assumptions on primitives. We get the effects of ad valorem taxes on advertising and the semi-elasticity of demand with respect to ads from the evidence in Sections 5 and

[17] Decision consumer surplus does not change for price-induced quantity changes because of the envelope theorem (the consumer's first order condition sets marginal decision utility of consumption equal to price at the margin).

[18] Producer surplus does not change for ad-induced quantity changes because of the envelope theorem (marginal profit from an additional ad is zero: the marginal revenue from an ad equals the marginal cost of ads).

6 of this paper respectively. We make one additional assumption to put the latter estimate in the appropriate units. The evidence in Section 6 concerns the effect of a dollar of ad spending on *dollars deposited*, while quantities in our model are *dollars wagered*. We assume that dollars wagered (and therefore revenues for firms and the government) are proportional to deposits, which means that we can directly import our estimate in percent terms without a conversion factor. Baseline consumer prices and ad valorem tax rates are average values in the U.S. from 2023–2025 [Ramsey, 2025].

Panel B reports on further primitives that we calibrate from the literature. Our estimates of price-sensitivity[19] and the uninternalized harms of betting come from Brown et al. [2025]. The uninternalized harms parameter from that paper captures internalities from misperceived financial losses and self-control problems. As discussed in Section 3, we assume zero marginal costs because sports betting is a digital good, though we relax this assumption in sensitivity analysis.

In Panel C, we report a few derived parameters that help clarify the mechanics of our simulation. Each tax instrument can reduce quantity wagered through two channels: an ads channel η_j^A and a price channel η_j^P. The quantity responses through these channels scale the importance of the social welfare components in the MEB equation (10). In our simulations of ad valorem taxes, prices do not change and the full impact of the tax on quantities comes from the ads channel. In our simulations of specific taxes, both channels are relevant. The specific tax passes through fully to prices. The tax also reduces firms' incentives to advertise. Intuitively, recall that we think about ads as randomly making consumers aware of the product. At a higher price, fewer newly aware consumers will choose to gamble when they are exposed to ads, so the marginal benefits of advertising fall.[20] In our simulations, a 1 cent increase in the tax on dollars wagered would reduce advertising by about as much as an 11 percentage point increase in the ad valorem tax (comparing row 13 to row 1). The ads channel accounts for about 20% of the effect of the specific tax on quantities, with the other 80% flowing through the price channel.

Finally, we compute the specific tax rate that would raise the same revenue as the baseline ad valorem tax of $\tau^{\text{Baseline}} = 21\%$, accounting for behavioral responses to taxes. This baseline rate is $t^{\text{Baseline}} = 2.80\%$. To make the comparison between ad valorem and specific taxes fair, we assume that the baseline ad valorem tax is in place when computing the burdens of raising

[19]Under the constant-semi-elasticity form, a 2¢ rise that cuts dollars wagered by 20% implies $e^{-0.02\, s^D_{Q,P}} = 0.8$, so $s^D_{Q,P} = -\ln(0.8)/0.02 = 11.2$.

[20]In general models, the direction of this effect is ambiguous, because ads and low prices could be substitutes in generating higher demand. But, with our multiplicative functional form, specific taxes always reduce advertising. In Lemma 2 of Appendix C.5, we derive dA/dt for the specific tax given our functional form.

one more dollar from the ad valorem tax and that the baseline specific tax is in place when computing the burdens of raising one more dollar from the specific tax.

Table 3: Baseline Scenario Parameters

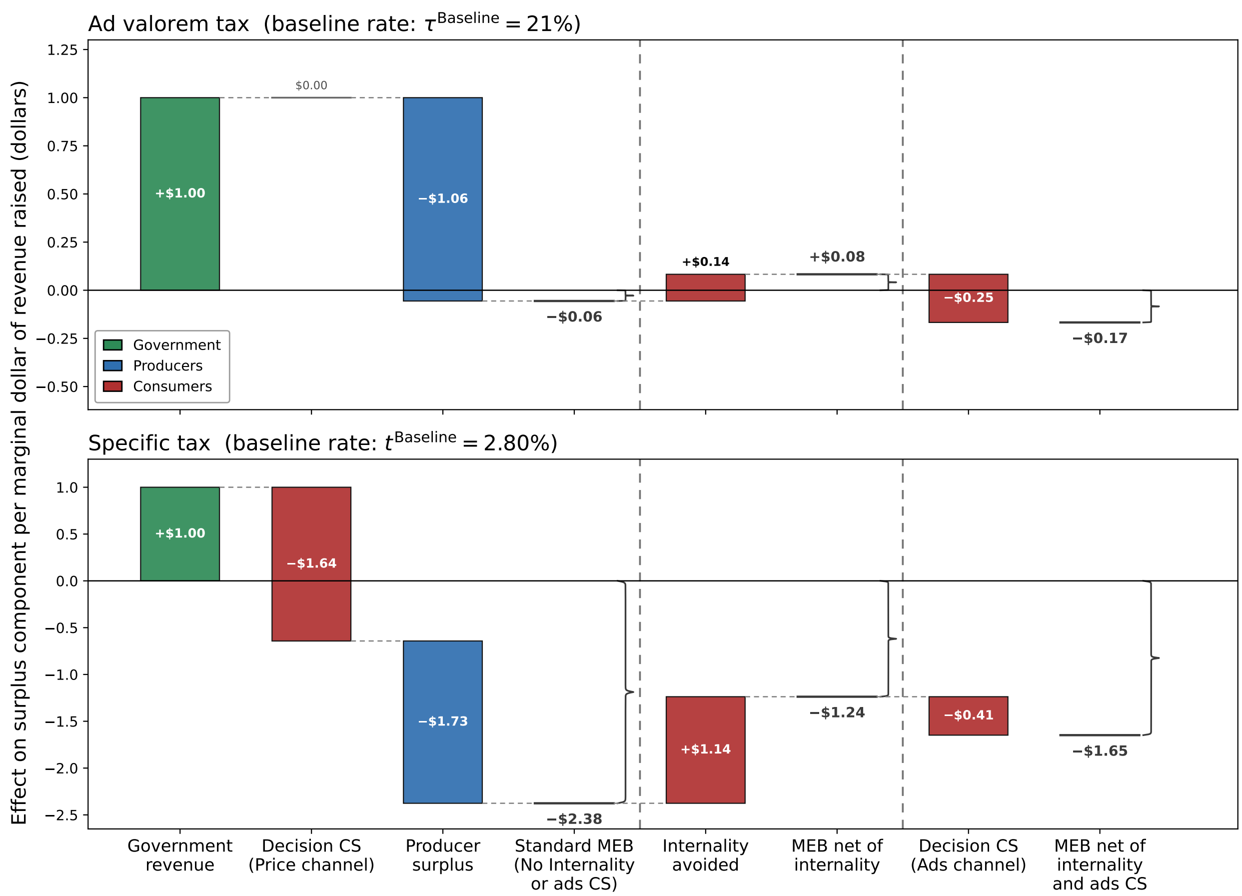
#	Parameter	Description	Units	Value	Source
		Panel A: Estimated and Observed Primitives			
1	$dA/d\tau$	Ad valorem association with per-firm advertising (within-firm-year)	(firm monthly ad \$/100 capita) per p.p.	0.046	Correlation in Fig. 5a
2	$s^D_{Q,A}$	Market semi-elasticity of dollars wagered w.r.t. a \$1 per 100-capita increase in advertising, by all firms	% industry \$ wagered per (\$1 ad/100 capita per month increase by all firms)	5.39	Border design (§6); full calc. App. A.4 (Table A9)
3	p	Consumer price	¢/\$ wagered	9.46	Average U.S. price, 2023–2025
4	τ^{Baseline}	Baseline ad valorem tax rate	% of revenue	21	Cumulative gov't revenue / firm revenue, U.S. 2023–2025
		Panel B: Calibrated Primitives			
5	$s^D_{Q,P}$	Market semi-elasticity of demand w.r.t. price	% \$ wagered per 1¢ increase in price	11.2	Calibrated to Brown et al. [2025]
6	ζ	Uninternalized harms	¢/\$ wagered	4.97	Calibrated to Brown et al. [2025]
7	MC	Marginal cost	¢/\$ wagered	0	Calibrated (digital good)
		Panel C: Derived Parameters			
Ad valorem tax					
8	η^P_τ	Ad valorem semi-elasticity, price channel	% \$ wagered per p.p.	0	Zero price effect (Prop. 1)
9	η^A_τ	Ad valorem semi-elasticity, ad channel	% \$ wagered per p.p.	0.25	Row 1 × 2
10	η^{Tot}_τ	Ad valorem total semi-elasticity	% \$ wagered per p.p.	0.25	Sum of rows 8 and 9
Specific tax					
11	dp/dt	Specific tax effect on price	unitless	1	Implied by constant semi-elasticity (Assumption 3)
12	η^P_t	Specific semi-elasticity, price channel	% \$ wagered per 1¢ increase in tax	11.2	Row 11 × 5
13	dA/dt	Specific tax effect on per-firm advertising	(firm monthly ad \$/100 capita) per 1¢ increase in tax	0.51	Row 5 × 1 (Lemma 2, App. C.4)
14	η^A_t	Specific semi-elasticity, ad channel	% \$ wagered per 1¢ increase in tax	2.8	Row 13 × 2
15	η^{Tot}_t	Specific total semi-elasticity	% \$ wagered per 1¢ increase in tax	14.0	Sum of rows 12 and 14
16	t^{Baseline}	Baseline specific tax rate	¢/\$ wagered	2.80	Revenue-equivalent to τ^{Baseline}

Notes: All semi-elasticities apply to market-level quantities, not firm-specific quantities.

7.3 Baseline Scenario Results

In Figure 7, we decompose the welfare effects of raising one marginal dollar of revenues from ad valorem and specific taxes into effects on decision consumer surplus, producer surplus, and internalities, as specified in Proposition 2. We further disaggregate effects on decision consumer surplus into effects driven by the price channel and effects driven by the ads channel. Moving from left to right, we illustrate three MEBs, starting by accounting for neither internalities nor ads channel CS effects, then adding internalities, then adding both.

Figure 7: Simulated effects of marginal taxes on disaggregated surplus components



Notes: Both panels study the impact of a marginal tax increase that raises $1 of revenue, beginning from baseline rates that raise equivalent baseline revenues under the model (21% for the ad valorem tax and 2.80% for the specific tax). We use the calibrated parameters in Table 3 to conduct the simulation. Formulas for effects on surplus components per dollar of revenue raised are given in Proposition 2.

The bars in the left half of Figure 7 represent standard tax burdens in the presence of market power. From this conventional perspective, the ad valorem tax is close to a nondistortionary profits tax. Consumers are unharmed because prices do not change, and the only source of deadweight loss is the small base erosion term from advertising reductions.[21] By contrast, the specific tax imposes large costs on both firms and consumers. Consumers bear the full burden of tax's impact on prices, and firms are also harmed because the tax reduces quantities for a marked up product. In the language of Weyl and Fabinger [2013], market power means that consumers and firms "more than fully share" the burdens of the tax. For this reason, the MEB of the specific tax is much larger than that of the ad valorem tax.

Accounting for internalities narrows this efficiency gap but does not close it. Since the specific tax affects prices, it reduces betting by more than the ad valorem tax. Therefore, the corrective benefits of the specific tax are larger. Still, at our calibrated internality of $\zeta = 4.97$ cents per dollar wagered, the corrective benefits are not large enough to make the specific tax more efficient. One reason for this is that since we assume zero marginal costs, the pre-tax markup (9.46 cents per dollar wagered) already exceeds the internality. Because of this markup (and the existing baseline taxes), the price of betting is already *above* the socially efficient price, and taxes that raise prices even more only exacerbate this distortion.

Both taxes reduce advertising. In our model, this reduced advertising is socially costly because fewer people get the opportunity to consume a product they enjoy. Readers who are more pessimistic about the welfare effects of ad-induced consumption may choose to ignore these welfare effects. Ultimately, since both the ad valorem tax and the specific tax reduce incentives to advertise, these effects do not change the qualitative conclusion that the ad valorem tax is more efficient.

The total surplus effect from raising a marginal dollar of revenue through the ad valorem tax, inclusive of internalities and welfare effects of advertising, is \$0.17. This MEB is comparable to that of alternative prominent revenue-raisers. As one point of comparison, Saez et al. [2012] puts the midpoint of estimates of the MEB from raising the top marginal income tax rate in the U.S. at -0.38. Most of the incidence falls on sportsbooks, which may make the tax attractive on distributional grounds as well. Specific taxes have larger corrective benefits, but under our calibration this is not enough to overcome their conventional efficiency costs. We next test the robustness of our conclusions to alternative parameterizations.

7.4 Sensitivity

Table 4 reports on the quantity effects (change in dollars wagered per dollar of revenue raised), incidence ($\Delta PS/(\Delta CS + \Delta PS)$ for marginal tax increases), and efficiency (MEB) of

[21] The elasticity of the tax base with respect to τ is $\varepsilon_{base} = \tau \cdot \eta_\tau^A = 21\% \times 0.25\% \approx 5.3\%$. The standard Harberger formula gives MEB $= -\varepsilon_{base}/(1 - \varepsilon_{base}) \approx -0.06$ per dollar raised.

ad valorem and specific taxes. The first row reports results from our main parameterization; the following rows consider alternatives.

Table 4: Quantity effect, incidence, and efficiency under alternative calibrations

	Quantity effect		**Incidence on firms**		**Efficiency**		
	$\Delta\$\,\text{wagered}/\Delta G$		$\Delta PS\,/\,(\Delta CS + \Delta PS)$		$\text{MEB} = (-\Delta TS)/\Delta G$		
	τ	t	τ	t	τ	t	Diff
1. Baseline	-2.8	-22.9	90%	65%	-0.17	-1.65	-1.48
2. Taxes do not affect ads	-0.0	-16.0	100%	70%	0.00	-1.15	-1.15
3. Ad-sensitivity of demand doubled	-5.9	-33.0	83%	61%	-0.35	-2.40	-2.05
4. Zero CS on ad-marginal units	-2.8	-22.9	115%	77%	0.08	-1.24	-1.32
5. Zero internality	-2.8	-22.9	81%	46%	-0.31	-2.79	-2.48
6. Double internality	-2.8	-22.9	103%	115%	-0.03	-0.51	-0.48
7. Perf. comp. ($\theta = 0$, taxes do not affect ads)	-14.4	-14.3	0%	0%	0.43	0.43	0.00
8. MC: DraftKings' 10-K (20% of price)	-6.6	-20.1	79%	60%	-0.27	-0.99	-0.72
9. MC: 62% of price	-14.7	-15.6	42%	32%	-0.01	0.08	0.08

Notes: Each row applies a one-parameter deviation from the baseline calibration. All rows evaluated at the U.S. revenue-weighted ad valorem rate ($\tau = 21\%$) and its revenue-equivalent specific rate ($t^* = 2.80\%$). *Quantity effect* ($\Delta\$\,\text{wagered}/\Delta G$): dollars of wagering eliminated per marginal dollar of government revenue raised; negative because taxes reduce wagering. *Efficiency* ($\text{MEB} = (-\Delta TS)/\Delta G$): marginal excess burden per dollar of revenue raised; more negative is worse, positive means the tax is net welfare-improving. *Incidence* ($\Delta PS/(\Delta CS + \Delta PS)$): firm share of the total private welfare burden, with ΔCS net of the internality correction ζ; values outside $[0, 100]\%$ arise when the internality benefit to consumers exceeds their gross surplus loss. For marginal-cost rows ($\kappa > 0$), the incidence split includes price pass-through $dp/d\tau = \kappa/(1-\tau)^2$.

The effect that the ad valorem tax has on advertising can change our qualitative conclusions about its efficiency and incidence. Row 2 shows that if we failed to account for the ads channel, the ad valorem tax would look like a nondistortionary profit tax with no effect on quantities, no incidence on consumers, and no deadweight loss, in contrast to the results from our main simulation. The ad-sensitivity of demand and the normative interpretation of advertising both determine the quantitative importance of accounting for advertisements. Rows 3 and 4 respectively consider alternative assumptions for these. If demand is more sensitive to ads, both taxes look less efficient, but if ad-induced consumption reductions are not costly, both taxes look more efficient. In the case where ad-induced consumption does not increase consumer surplus, consumers actually *benefit* from ad valorem taxes, because the only effect of the ad valorem tax on consumers is to reduce internalities from betting.

We next vary our assumptions about these uninternalized harms. Rows 5 and 6 set internalities per dollar wagered ζ to zero and double the baseline estimate respectively. The positive consequences of the tax are the same as our base parameterization for these rows, but normative implications for consumers vary dramatically – taxes are more beneficial for consumers when internalities are larger. Since our MEB number includes internalities, both taxes look more efficient when internalities are larger, and the efficiency gap between the taxes narrows. Still, even double internalities are not large enough to make the specific tax more efficient. To do that, we need to relax our assumptions about markups.

Rows 7 through 9 consider different assumptions about markups and competition. We begin with a benchmark case of perfect competition, where markups are zero and there is no ads channel (firms do not advertise because there is no incentive to do so). Under these assumptions, ad valorem taxes and specific taxes are identical.[22] Further, raising revenues through both taxes increases total surplus. While this is a useful case to build intuition about what drives our results, it does not reflect reality. As we have seen, ad valorem taxes and specific taxes have different market consequences, and sportsbooks almost certainly make variable profits per dollar wagered.[23] So, we now consider more realistic cases with positive marginal costs. In row 8, we set the marginal costs equal to 20% of price, consistent with the upper bound we calculate from DraftKings' 10-K (Section 2). In row 9, we set marginal costs equal to 62% of price, consistent with the average markup in the U.S. economy in 2016 as reported in De Loecker et al. [2020]. Under the upper bound on DraftKings's reported marginal costs, per-wager markups are still large and the ad valorem tax is still more efficient than the specific tax. If we modeled markups in the sports betting industry more like in other industries where firms sell physical goods, the specific tax would be more efficient.

8 Conclusion

The main tax instrument in the U.S. sports betting market is levied on sportsbook revenues. We show that this tax does not affect the price of sports betting. Instead, it reduces sportsbook marketing, which in turn reduces deposits to sportsbooks. We estimate the ad-sensitivity of sportsbook deposits, and combine this estimate with others from the literature to compare the prevailing ad valorem tax to a revenue-equivalent specific tax. Because sports wagers are a digital good sold with high markups, specific taxes impose large burdens on both consumers and firms so the ad valorem tax is more efficient. If sportsbooks had less market power or if the planner places more weight on correcting uninternalized harms of betting, the specific tax can look more attractive. Our empirical evidence on consumer responses to sports betting advertisements also has broader relevance for the design of non-tax policies, such as restrictions on sports betting advertising.

[22]In practice there are slight differences in Table 4. All effects would be exactly the same if we started from a baseline $t = p \cdot \tau^{Baseline}$. In fact, we start from a t that delivers the same *revenue* as the ad valorem tax instead of the same price under our main parameterization, so the taxes have slightly different effects.

[23]Indeed, the fact that we observe such different price effects for ad valorem versus specific taxes is an indicator that sportsbooks have significant market power [Delipalla and O'Donnell, 2001].

We highlight three directions for future work. First, while we provide some evidence on the characteristics of ad-responsive consumers, we do not link measures of bias to ad-responsiveness at the individual level. Whether policies that reduce advertising are well-targeted depends on whether ad-marginal consumption causes more uninternalized harms than average consumption. This comparison is relevant for sports betting and for other goods with internalities and externalities; future work could try to measure the targeting properties of ad restrictions. Second, taxes may cause firms to reduce advertising for other goods with internalities or externalities. There is some empirical work in public health on this, such as Hua et al. [2024], but we think this margin is understudied. Third, our strong assumptions in Section 7 could be relaxed to establish general sufficient-statistics formulae for optimal taxes that incorporate endogenous firm advertising.

References

Rossi Abi-Rafeh, Pierre Dubois, Rachel Griffith, and Martin O'Connell. The effects of sin taxes and advertising restrictions in a dynamic equilibrium. *American Economic Journal: Microeconomics*, 2025. (Forthcoming).

American Gaming Association. Commercial gaming revenue tracker: Cy 2025, February 2026. URL https://www.americangaming.org/wp-content/uploads/2026/03/CY-2025_CGRT.pdf.

Scott R. Baker, Justin Balthrop, Mark J. Johnson, Jason D. Kotter, and Kevin Pisciotta. Gambling away stability: Sports betting's impact on vulnerable households. Working Paper 33108, National Bureau of Economic Research, November 2024. URL http://www.nber.org/papers/w33108.

Yoram Barzel. An alternative approach to the analysis of taxation. *Journal of Political Economy*, 84(6):1177–1197, 1976. doi: 10.1086/260507.

Gary S. Becker and Kevin M. Murphy. A simple theory of advertising as a good or bad. *The Quarterly Journal of Economics*, 108(4):941–964, November 1993. doi: 10.2307/2118455. URL https://doi.org/10.2307/2118455.

Marianne Bertrand, Dean Karlan, Sendhil Mullainathan, Eldar Shafir, and Jonathan Zinman. What's advertising content worth? evidence from a consumer credit marketing field experiment. *The Quarterly Journal of Economics*, 125(1):263–306, 2010. doi: 10.1162/qjec.2010.125.1.263.

Andy Beshear. Budget Address, January 2020. URL https://governor.ky.gov/attachments/20200128_Budget-Address.pdf. Accessed: 2026-03-25.

BetMGM. Best welcome casino bonus. Archived webpage, October 2025. URL https://web.archive.org/web/20251009220452/https://casino.betmgm.com/en/blog/best-welcome-casino-bonus/.

Thomas Blake, Chris Nosko, and Steven Tadelis. Consumer heterogeneity and paid search effectiveness: A large-scale field experiment. *Econometrica*, 83(1):155–174, 2015. doi: 10.3982/ECTA12423.

Francis Bloch and Gabrielle Demange. Taxation and privacy protection on Internet platforms. *Journal of Public Economic Theory*, 20(1):52–66, 2018.

Pedro Bordalo, Giovanni Burro, Nicola Gennaioli, Gad Nacamulli, and Andrei Shleifer. Ads as cues. Working Paper 34387, National Bureau of Economic Research, 2025.

Marc Bourreau, Bernard Caillaud, and Romain De Nijs. Taxation of a digital monopoly platform. *Journal of Public Economic Theory*, 20(1):40–51, 2018.

Timothy F. Bresnahan. Empirical studies of industries with market power. In Richard Schmalensee and Robert Willig, editors, *Handbook of Industrial Organization*, volume 2, pages 1011–1057. North-Holland, Amsterdam, 1989.

Matthew Brown, Nick Grasley, and Mariana Guido. Do Sports Bettors Need Consumer Protection? Evidence from a Field Experiment. Working paper, Stanford University, 2025. URL https://mattbrownecon.github.io/assets/papers/jmp/sportsbetting.pdf.

Gerard R. Butters. Equilibrium distributions of sales and advertising prices. *The Review of Economic Studies*, 44(3):465–491, 1977.

R. Andrew Butters, Daniel W. Sacks, and Boyoung Seo. How do national firms respond to local cost shocks? *American Economic Review*, 113(6):1737–1772, 2023. doi: 10.1257/aer.20210811.

Casino Reports. US sports betting market stats database. Database, 2025. URL https://www.casinoreports.com/us-sports-betting-market-stats-database/. In collaboration with Alfonso Straffon, citing state filings.

Martin J. Chegere, Paolo Falco, Marco G. Nieddu, Lorenzo Pandolfi, and Mattea Stein. The magic of the game: Experimental evidence on sports betting behavior. *Journal of Economic Behavior & Organization*, 240:107301, 2025. doi: 10.1016/j.jebo.2025.107301.

Jiafeng Chen and Jonathan Roth. Logs with zeros? some problems and solutions. *The Quarterly Journal of Economics*, 139(2):891–936, May 2024. doi: 10.1093/qje/qjad054.

Augustin Cournot. *Researches into the Mathematical Principles of the Theory of Wealth*. 1838. Translated from the French by Nathaniel T. Bacon; English edition published by The Macmillan Company, New York, 1897. Originally published as Recherches sur les principes mathématiques de la théorie des richesses.

Covers.com. Fanatics Illinois sports betting surcharge, July 2025. URL https://www.covers.com/industry/fanatics-illinois-sports-betting-surcharge-july-1-2025.

Jacques Crémer. Taxing network externalities. In *Taxation and the Digital Economy: A Survey of Theoretical Models*. France Stratégie, February 2015.

Wei Cui. The digital services tax: A conceptual defense. *Tax Law Review*, 73(1):69–111, 2019.

DarkHorse Odds. DarkHorse Odds: Sports betting arbitrage consulting. Website, 2025. URL https://www.darkhorseodds.com.

Jan De Loecker, Jan Eeckhout, and Gabriel Unger. The rise of market power and the macroeconomic implications. *The Quarterly journal of economics*, 135(2):561–644, 2020.

Deadspin. BetMGM Illinois implements higher minimum bet cost to offset tax increase, 2025. URL https://web.archive.org/web/20260218174027/https://deadspin.com/legal-betting/betmgm-illinois-implements-higher-minimum-bet-cost-to-offset-tax-increase/.

Sofia Delipalla and Michael Keen. The comparison between ad valorem and specific taxation under imperfect competition. *Journal of Public Economics*, 49(3):351–367, 1992.

Sophia Delipalla and Owen O'Donnell. Estimating tax incidence, market power and market conduct: The european cigarette industry. *International Journal of Industrial Organization*, 19(6):885–908, 2001.

Stefano DellaVigna and Matthew Gentzkow. Uniform pricing in u.s. retail chains. *The Quarterly Journal of Economics*, 134(4):2011–2084, None 2019. doi: None. URL https://ideas.repec.org/a/oup/qjecon/v134y2019i4p2011-2084..html.

Kwabena Donkor, Lorenz Goette, Maximilian W. Müller, Eugen Dimant, and Michael J. Kurschilgen. The price of identity: Overoptimism and congruence concerns. Available at SSRN: https://ssrn.com/abstract=4670092, 2025.

DraftKings. Q2 2024 earnings call transcript. Earnings call via Insider Monkey, 2024a. URL https://www.insidermonkey.com/blog/draftkings-inc-nasdaqdkng-q2-2024-earnings-call-transcript-1329726/.

DraftKings. Q3 2024 investor relations materials. Investor relations, 2024b. URL https://draftkings.gcs-web.com/static-files/436fd512-12f4-4c0e-b4ef-87472a2f7a8d.

DraftKings. Illinois wager tax FAQs, 2025a. URL https://support.draftkings.com/dk/en-us/illinois-wager-tax-faqs-us?id=kb_article_view&sysparm_article=KB0011351.

DraftKings. Q2 2025 earnings call transcript. Earnings call via GuruFocus, August 2025b. URL https://www.gurufocus.com/news/3047735/q2-2025-draftkings-inc-earnings-call-transcript.

Pierre Dubois, Rachel Griffith, and Martin O'Connell. The effects of banning advertising in junk food markets. *The Review of Economic Studies*, 85(1):396–436, 01 2018. ISSN 0034-6527. doi: 10.1093/restud/rdx025. URL https://doi.org/10.1093/restud/rdx025.

Entain Group. BetMGM investor day transcript. Investor presentation, May 2022. URL https://www.entaingroup.com/media/bfcdjy1d/22betmgm-cmd-transcript-1.pdf.

ESPN. How does regional home-team bias impact sportsbooks? News article, January 2020. URL https://www.espn.com/chalk/story/_/id/28533298/how-does-regional-home-team-bias-impact-sportsbooks.

Flutter Entertainment. Q2 2024 results announcement. SEC filing, 2024. URL https://www.sec.gov/Archives/edgar/data/1635327/000119312524199772/d744140dex991.htm.

Gartner. Gartner 2025 CMO spend survey reveals marketing budgets have flatlined at 7.7% of overall company revenue, may 2025. URL https://www.gartner.com/en/newsroom/press-releases/2025-05-12-gartner-2025-cmo-spend-survey-reveals-marketing-budgets-have-flatlined-at-

Matthew Gentzkow, Jesse M Shapiro, Frank Yang, and Ali Yurukoglu. Pricing power in advertising markets: Theory and evidence. *American Economic Review*, 114(2):500–533, 2024. doi: 10.1257/aer.20220943.

Jacob Goss and Daniel Mangrum. Sports betting across borders: Spatial spillovers, credit distress, and fiscal externalities. Staff Reports 1184, Federal Reserve Bank of New York, March 2026. Revised March 2026.

Dustin Gouker. Introducing the handle: New paywalled content about us online gambling data, January 2026. URL https://closingline.substack.com/p/introducing-the-handle-new-content-about-us-gambling-data. Reports preliminary 2025 U.S. sports betting handle and online handle share using state regulator data.

Jonathan Guryan and Melissa S. Kearney. Is lottery gambling addictive? *American Economic Journal: Economic Policy*, 2(3):90–110, August 2010. doi: 10.1257/pol.2.3.90. URL https://www.aeaweb.org/articles?id=10.1257/pol.2.3.90.

Bianca He, Lauren I Mostrom, and Amir Sufi. Investing in customer capital. Working Paper 33171, National Bureau of Economic Research, November 2025. URL http://www.nber.org/papers/w33171.

Brett Hollenbeck and Kosuke Uetake. Taxation and market power in the legal marijuana industry. *The RAND Journal of Economics*, 52(3):559–595, 2021. doi: https://doi-org.proxy.uchicago.edu/10.1111/1756-2171.12384. URL https://onlinelibrary-wiley-com.proxy.uchicago.edu/doi/abs/10.1111/1756-2171.12384.

Brett Hollenbeck, Poet Larsen, and Davide Proserpio. The financial consequences of legalized sports gambling. Manuscript dated April 2025, April 2025.

Sophia V Hua, Matthew M Lee, Rebecca Mozaffarian, Sara N Bleich, Christina A Roberto, Frances Fleming-Milici, Briana Stephenson, and Erica L Kenney. Philadelphia beverage tax's impact on beverage ad expenditures and number of ads purchased. *American Journal of Preventive Medicine*, 67(2):274–281, 2024. doi: 10.1016/j.amepre.2024.03.011.

Illinois Gaming Board. FAQs on new statutory sports wager tax. Press release, June 2025. URL https://igb.illinois.gov/content/dam/soi/en/web/igb/documents/press-releases/additional-news/20250617-faqs-on-new-statutory-sports-wager-tax.pdf.

Johannes Kasinger. Shrouded sin taxes. *arXiv preprint arXiv:2409.01493*, 2024. doi: 10.48550/arXiv.2409.01493. URL https://arxiv.org/abs/2409.01493.

Michael Keen. The balance between specific and ad valorem taxation. *Fiscal Studies*, 19(1): 1–37, 1998.

Hans Jarle Kind and Marko Koethenbuerger. Taxation in digital media markets. *Journal of Public Economic Theory*, 20(1):22–39, 2018. doi: 10.1111/jpet.12257.

Kory Kroft, Jean-William P. Laliberté, René Leal-Vizcaíno, and Matthew J. Notowidigdo. Salience and taxation with imperfect competition. *Review of Economic Studies*, 91(1): 415–454, 2024. doi: 10.1093/restud/rdad031.

Poet Larsen, Sriniketh Vijayaraghavan, and Uttara M. Ananthakrishnan. Cross-channel demand for addictive goods: Evidence from online sports gambling and state lotteries. Technical Report 5413774, Available at SSRN, 2025.

Legal Sports Report. DraftKings seeks favorable alternative to fee on winning bettors. News article, September 2024. URL https://www.legalsportsreport.com/199765/draftkings-seeks-favorable-alternative-to-fee-on-winning-bettors/.

Legal Sports Report. BetRivers raises Illinois minimum as sports bets fall, 2025a. URL https://web.archive.org/web/20260306140012/https://www.legalsportsreport.com/250740/betrivers-raises-illinois-minimum-as-sports-bets-fall/.

Legal Sports Report. Florida sports betting. State guide, 2025b. URL https://www.legalsportsreport.com/sports-betting-states/florida/.

Alfred Marshall. *Principles of Economics*. Macmillan and Co., London, 8 edition, 1920. URL https://oll.libertyfund.org/title/1676. Online Library of Liberty PDF, generated September 2011.

Kyutaro Matsuzawa and Emily Arnesen. Sports betting legalization amplifies emotional cues & intimate partner violence. *SSRN Electronic Journal*, aug 2024. doi: 10.2139/ssrn.4938642. URL https://ssrn.com/abstract=4938642.

Daniel M. McCarthy, Wayne J. Taylor, and Kenneth C. Wilbur. Online market launch and the distribution of gambling risk: Evidence from online sports betting. SMU Cox School of Business Research Paper No. 24-7. Posted June 10, 2024; last revised April 9, 2026, April 2026.

E. McGrane, H. Wardle, M. Clowes, L. Blank, R. Pryce, M. Field, C. Sharpe, and E. Goyder. What is the evidence that advertising policies could have an impact on gambling-related harms? A systematic umbrella review of the literature. *Public Health*, 215:124–130, 2023. doi: 10.1016/j.puhe.2022.11.019.

New Hampshire Public Radio. Vermont selects three companies to usher in state sports betting system. News article, December 2023. URL https://www.nhpr.org/2023-12-12/vermont-selects-three-companies-to-usher-in-state-sports-betting-system.

Stephen Nickell. Biases in dynamic models with fixed effects. *Econometrica*, 49(6):1417–1426, 1981.

North American Association of State and Provincial Lotteries. Lottery Sales and Revenues: FY 2025, 2025. URL https://filestore.nasplmatrix.org/public/emails/FY25_Lottery_Sales_and_Revenues_FINAL.pdf. Reports U.S. traditional lottery game sales of $96,165,420,861 for fiscal year 2025. Figures are preliminary and unaudited.

D. Ó Ceallaigh, S. Timmons, D. A. Robertson, and P. D. Lunn. Effects of inducements on sports gambling and decision-errors: An experimental study. *Journal of Behavioral Addictions*, 14(2):959–971, 2025. doi: 10.1556/2006.2025.00056.

Jeremy Pelzer. Mike DeWine says biggest mistake as governor was to sign bill legalizing sports gambling. cleveland.com, January 2026. URL https://www.cleveland.com/news/2026/01/mike-dewine-says-biggest-mistake-as-governor-was-to-sign-bill-legalizing-sports-gambl html. Accessed 2026-05-25.

Penn Entertainment. Q3 2024 earnings call. Earnings call transcript, 2024. URL https://www.alphaspread.com/security/nasdaq/penn/investor-relations/earnings-call/q3-2024.

Marc N. Potenza, Iris M. Balodis, Jeffrey Derevensky, Jon E. Grant, Nancy M. Petry, Antonio Verdejo-Garcia, and Sarah W. Yip. Gambling disorder. *Nature Reviews Disease Primers*, 5(1):51, 2019. doi: 10.1038/s41572-019-0099-7.

Eric Ramsey. Us sports betting revenue and handle by state. Legal Sports Report, 2025. URL https://www.legalsportsreport.com/sports-betting-states/revenue/.

Emmanuel Saez, Joel Slemrod, and Seth H Giertz. The elasticity of taxable income with respect to marginal tax rates: A critical review. *Journal of economic literature*, 50(1): 3–50, 2012.

J. M. C. Santos Silva and Silvana Tenreyro. The log of gravity. *The Review of Economics and Statistics*, 88(4):641–658, November 2006. doi: 10.1162/rest.88.4.641.

SBC Americas. NY sports betting hearing 2023: Tax rate discussion. News article, February 2023. URL https://sbcamericas.com/2023/02/01/ny-sports-betting-hearing-2023-tax-rate/.

SBC Americas. bet365 Illinois $10 25-cent fee, September 2025a. URL https://sbcamericas.com/2025/09/02/bet365-illinois-10-dollar-25-cent-fee/.

SBC Americas. Caesars Illinois 25-cent per-wager fee, August 2025b. URL https://sbcamericas.com/2025/08/26/caesars-illinois-25-cent-per-wager-fee/.

SBC Americas. Illinois sports betting tax: September impact, November 2025c. URL https://sbcamericas.com/2025/11/17/illinois-sports-betting-tax-september/.

Raj Sethuraman, Gerard J. Tellis, and Richard A. Briesch. How well does advertising work? Generalizations from meta-analysis of brand advertising elasticities. *Journal of Marketing Research*, 48(3):457–471, 2011. doi: 10.1509/jmkr.48.3.457.

Bradley Shapiro. Positive spillovers and free riding in advertising of prescription pharmaceuticals: The case of antidepressants. *Journal of Political Economy*, 126(1):381–437, 2018. doi: 10.1086/695475. URL https://doi.org/10.1086/695475.

Bradley T Shapiro, Günter J Hitsch, and Anna Tuchman. Research note: Procedure for building nielsen ad intel data and merging with nielsen rms scanner data. Working paper, SSRN, 2020. URL https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3761483.

Bradley T Shapiro, Günter J Hitsch, and Anna Tuchman. Tv advertising effectiveness and profitability: Generalizable results from 288 brands. *Econometrica*, 89(4):1855–1879, 2021. doi: 10.3982/ECTA17674.

SportsHandle. New york sports betting. State guide, October 2025. URL https://sportshandle.com/new-york/.

Daniel B. Suits. The elasticity of demand for gambling. *The Quarterly Journal of Economics*, 93(1):155–162, 1979. URL http://www.jstor.org/stable/1882605.

Daniel B. Suits and Richard A. Musgrave. Ad valorem and unit taxes compared. *Quarterly Journal of Economics*, 67(4):598–604, 1953.

The Wall Street Journal. The arbitrage consultants promising risk-free sports betting. *The Wall Street Journal*, 2024. URL https://www.wsj.com/business/the-arbitrage-consultants-promising-risk-free-sports-betting-c1aea930.

Paul Tonko. SAFE Bet Act fact sheet. Congressional fact sheet, 2025. URL https://tonko.house.gov/uploadedfiles/safe_bet_fact_sheet_3.25_119th.pdf.

E. Glen Weyl and Michal Fabinger. Pass-through as an economic tool: Principles of incidence under imperfect competition. *Journal of Political Economy*, 121(3):528–583, 2013. doi: 10.1086/670401. URL https://www.jstor.org/stable/10.1086/670401.

A Additional Tables and Figures Appendix

A.1 Estimating National Promotional Credit Spending

In Table A2, we estimate national promotional credit spending by extrapolating from state-level administrative data. We walk through the DraftKings calculation using Ohio data as an example.

The Ohio Casino Control Commission reports that DraftKings offered $103M in promotional credits (face value) in calendar year 2024, on $2.91B in dollars wagered in Ohio. This implies a promotional credit rate of 3.54% of dollars wagered. If DraftKings offers promotional credits at a similar rate nationwide, we can extrapolate to a national face value of $\$48.10B \times 3.54\%$.

However, promotional credits are not worth their face value. A $100 bonus bet, for example, cannot be converted to $100 in cash with certainty. We consider two conversion rates. The "low" rate of 45¢ on the dollar assumes users naively bet into standard -110 two-way markets. The "high" rate of 70¢ on the dollar assumes users exploit promos optimally, using the DarkHorse Odds conversion rate for bonus bets (see Section 4).

At the high conversion rate, DraftKings' national promotional credit cost is $1.19B, which is 113.5% of their $1.05B advertising spend. At the low conversion rate, the cost is $766M, or 72.9% of advertising.

The promo-to-dollars-wagered ratios differ across states and sportsbooks. Table A2 presents the full set of calculations for two sportsbooks (DraftKings and FanDuel) and two states (Ohio, using calendar year 2024 data, and Pennsylvania, using fiscal year July 2024 – June 2025 data). These estimates assume sportsbooks offer promos at the same rate nationwide as they do in these states. Ohio legalized sports betting relatively recently (January 2023), which may lead to higher promo rates. Pennsylvania allows promotional credit deductibility but has a relatively high tax rate (36%).

A.2 Promotional Offer Values by Sportsbook

Table A3 shows how we compute the expected dollar value of promotional sign-up offers as of January 23, 2026. Conversion rates follow DarkHorse Odds [DarkHorse Odds, 2025]: bonus bets at $0.70 on the dollar, risk-free bets ("second chance" or "safety net" offers) at $0.50 on the dollar, and 100% profit boosts at $0.66 on the dollar (reflecting that bettors can hedge on underdogs to extract guaranteed value).

A.3 Chained Effect of a 1 p.p. Tax Increase on Deposits, Through Advertising

We combine the tax→ads association with the ads→deposits causal effect to get the implied effect of a 1 p.p. tax increase on deposits through advertising. Table A8 lists each input, its units, and its source.

The fitted ad-response function evaluated in Row 12 is

$$\begin{aligned}\Delta \ln Q &= \hat{\gamma}_1(a^{\text{own}}_{\text{post}} - \bar{a}^{\text{own}}) + \hat{\gamma}_2(a^{\text{rival}}_{\text{post}} - \bar{a}^{\text{rival}}) \\ &\quad + \hat{\gamma}_3\left[(a^{\text{own}}_{\text{post}})^2 - (\bar{a}^{\text{own}})^2\right] + \hat{\gamma}_4\left[(a^{\text{rival}}_{\text{post}})^2 - (\bar{a}^{\text{rival}})^2\right] \\ &\quad + \hat{\gamma}_5\left[a^{\text{own}}_{\text{post}} a^{\text{rival}}_{\text{post}} - \bar{a}^{\text{own}}\bar{a}^{\text{rival}}\right] \\ &= \hat{\gamma}_1(3.344 - 3.39) + \hat{\gamma}_2(7.871 - 7.98) \\ &\quad + \hat{\gamma}_3\left[(3.344)^2 - (3.39)^2\right] + \hat{\gamma}_4\left[(7.871)^2 - (7.98)^2\right] \\ &\quad + \hat{\gamma}_5\left[3.344 \times 7.871 - 3.39 \times 7.98\right] \\ &= -0.0025,\end{aligned}$$

where $a^{\text{own}}_{\text{post}} = \bar{a}^{\text{own}} + \Delta a^{\text{own}}$ and $a^{\text{rival}}_{\text{post}} = \bar{a}^{\text{rival}} + \Delta a^{\text{rival}}$.

A.4 Semi-Elasticity of Dollars Wagered to Industry Advertising

Row 2 of Table 3 reports $s^D_{Q,A}$, the semi-elasticity of industry dollars wagered with respect to a \$1-per-100-resident increase in monthly advertising by every sportsbook at once. It is the directional derivative of the fitted log-deposit ad-response function (Table 2, col. 1) at the sample mean, taken along the ray on which own and rival ad spending expand in proportion, so the \$1 step in own ads is matched by a $\bar{a}^{\text{rival}}/\bar{a}^{\text{own}}$ step in the rival sum. Table A9 lists each input and step.

In closed form,

$$\begin{aligned}s^D_{Q,A} &= 100\left[\underbrace{\left(\hat{\gamma}_1 + 2\hat{\gamma}_3\bar{a}^{\text{own}} + \hat{\gamma}_5\bar{a}^{\text{rival}}\right)}_{\partial \ln Q/\partial a^{\text{own}}} + \frac{\bar{a}^{\text{rival}}}{\bar{a}^{\text{own}}}\underbrace{\left(\hat{\gamma}_2 + 2\hat{\gamma}_4\bar{a}^{\text{rival}} + \hat{\gamma}_5\bar{a}^{\text{own}}\right)}_{\partial \ln Q/\partial a^{\text{rival}}}\right] \\ &= 100\left[0.01862 + 2.354 \times 0.01501\right] = 5.39\end{aligned}$$

A.5 Promotional Sign-Up Offers

Unlike television advertising, promotional offers are specifically targeted at new customers. So, when estimating the effects of sign-up offers, we focus on this population. Since we do not anticipate effects of sign-up offers on existing customers, we use this population as a placebo check.

To do this exercise, we require time variation within sportsbooks' promos. This required scraping archival data from the Internet Archive, and we are limited to what was archived historically; sportsbooks themselves do not list historical promotional offers.

Our historical promotional offer data is visible in Figure A8. The Internet Archive data restricts our analysis in three ways. First, we do not have state-level variation; the data we scrape is only the offer which Action Network lists as the headline offer for that sportsbook. It also means that not every person living in a legal state was able to use this offer in every period. Second, we only have reliable scraping for the three largest sportsbooks: FanDuel, DraftKings, and BetMGM. Third, the sample only goes back to July 2023. To get more power, we assume that if promo data is missing, a promo stayed in place for 30 days from the last time we observe it offered; after that, we treat that sportsbook's promo as missing.

A.5.1 Empirical Strategy

We estimate a week-level extensive margin elasticity with sportsbook and month fixed effects:

$$\ln(\text{Depositors}_{bw}) = \varepsilon \ln(\text{Promo}_{bw}) + \alpha_b + \delta_m + u_{bw} \tag{11}$$

Depositors is the number of Consumer Edge cards which make a deposit to that sportsbook in that week. Our specification is at the sportsbook $\times$ week level. b indexes sportsbook (DraftKings, FanDuel, BetMGM), w indexes week, and m indexes month. α_b are sportsbook fixed effects. δ_m are month fixed effects.

Within a month, we compare weeks when cross-book promo differences are large vs small. When a sportsbook's promo is higher relative to the other books, do its deposits rise relative to the others?

Book fixed effects absorb the fact that sportsbooks differ in size and promotional offer generosity. Month fixed effects absorb seasonal patterns common across books like the Super Bowl, March Madness, etc.

There are two threats to this analysis. First, we do not have sportsbook-month fixed effects, so if only DraftKings does a non-promo marketing push in a month, and that push is correlated with a bump in DraftKings' promos, the elasticity is upwardly biased. Second, we do not have week fixed effects. The elasticity is identified from cross-sportsbook changes in promos, so within-month unobserved demand shocks, common to all sportsbooks, bias our estimates if books differentially adjust promos in response to those shocks. For example, if all sportsbooks increase their promos a similar amount in the week of the Super Bowl, those promo changes do not contribute identifying variation to our elasticity estimate.

A.5.2 Results

Sign-up offers are only available to customers who have never deposited at that sportsbook, so we split depositors into two mutually exclusive groups: new-to-book customers, who have no prior deposit at that sportsbook, and existing customers, who have deposited before. We present results in figure A9.

We find a positive but noisy point estimate on the elasticity of new depositors to sign-up offers.

We test the effect on existing customers as a placebo. If sign-up offers show a positive effect on this group, that finding must be spurious: this group is ineligible to use sign-up promos. Any positive effect would have to be from unobserved demand shifters correlated with sign-up offers. The estimated elasticity for existing customers is a precise zero, consistent with our identifying assumption that cross-sportsbook promo variation within months is uncorrelated with other unobserved demand shifters.

A.6 Tables and Figures

Table A1: Market share by sportsbook, in dollars wagered, for the month of August 2025

Operator	Market Share (%)
DraftKings	35.2
FanDuel	29.6
BetMGM	14.3
Caesars	6.9
ESPN Bet (since rebranded as theScore Bet)	3.4
Rush Street Entertainment	3.4
Fanatics	2.6
bet365	1.3
Other	3.3

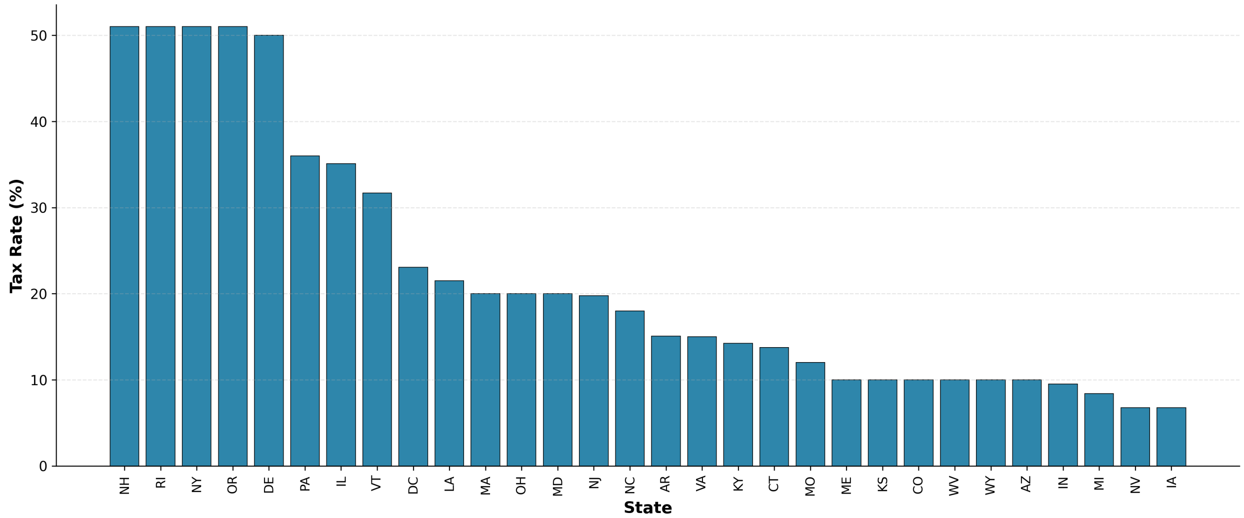
Notes: Source: Casino Reports [2025]. Rush Street Entertainment owns BetRivers.

Table A2: Estimates of national promotional credit costs for DraftKings and FanDuel (2024)

	Low Conversion (45¢)	**High Conversion (70¢)**
Panel A: DraftKings (National Dollars Wagered: $48.10B, Advertising: $1.05B)		
Pennsylvania (FY 2024-25)		
State promo credits (face value)	$76M	$76M
State dollars wagered	$2.25B	$2.25B
Promo rate (face value)	3.36%	3.36%
Promo cost rate	1.51%	2.35%
National promo cost (extrapolated)	$727M	$1.13B
Promos % of national advertising	69.2%	107.7%
Ohio (CY 2024)		
State promo credits (face value)	$103M	$103M
State dollars wagered	$2.91B	$2.91B
Promo rate (face value)	3.54%	3.54%
Promo cost rate	1.59%	2.48%
National promo cost (extrapolated)	$766M	$1.19B
Promos % of national advertising	72.9%	113.5%
Panel B: FanDuel (National Dollars Wagered: $50.90B, Advertising: $1.97B)		
Pennsylvania (FY 2024-25)		
State promo credits (face value)	$106M	$106M
State dollars wagered	$3.35B	$3.35B
Promo rate (face value)	3.17%	3.17%
Promo cost rate	1.43%	2.22%
National promo cost (extrapolated)	$726M	$1.13B
Promos % of national advertising	36.9%	57.5%
Ohio (CY 2024)		
State promo credits (face value)	$109M	$109M
State dollars wagered	$2.92B	$2.92B
Promo rate (face value)	3.73%	3.73%
Promo cost rate	1.68%	2.61%
National promo cost (extrapolated)	$854M	$1.33B
Promos % of national advertising	43.4%	67.6%

Notes: State-level promo credits and dollars wagered are from administrative data (Ohio Casino Control Commission, Pennsylvania Gaming Control Board). National dollars wagered and advertising are from 2024 10K filings. Low conversion rate (45¢) assumes naive betting into -110 markets. High conversion rate (70¢) uses DarkHorse Odds optimal conversion for bonus bets.

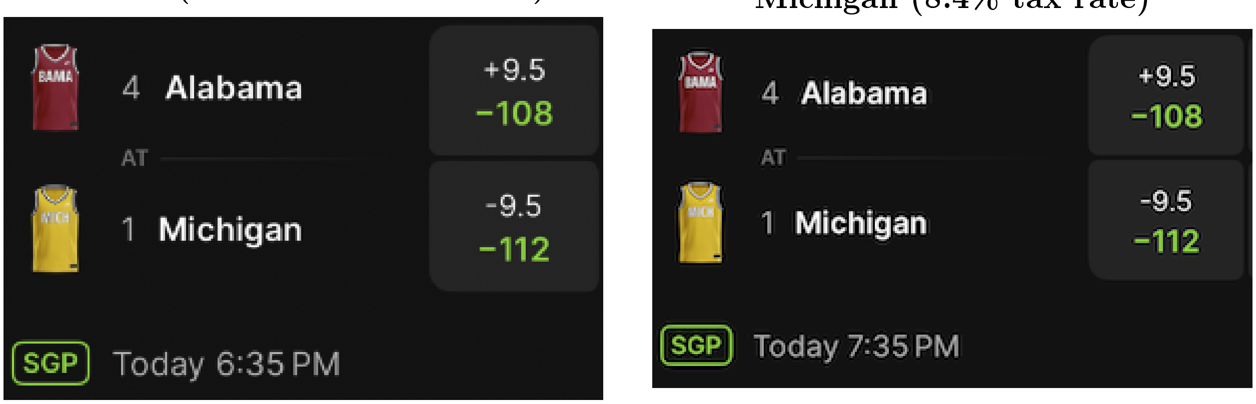
Figure A1: Tax rates on sports betting revenue (2025)



Notes: For Illinois, which has a graduated tax rate on operators, a per-wager tax, and county-level taxation, we show the average tax rate inclusive of all taxes, calculated as total tax payment divided by revenue for online sports betting for October 2024–September 2025. For Arkansas, which has a graduated tax rate, we use the average tax rate for total sports betting (online and retail combined) from September 2024–August 2025. Vermont negotiates revenue-sharing with each sportsbook, which is between 31% and 33% for FanDuel, DraftKings, and Fanatics [New Hampshire Public Radio, 2023]; we use the value reported by the State Tax Foundation here. For Washington, DC, different operators face different rates; we use the average tax rate for total sports betting (online and retail combined) from September 2024–August 2025.

Figure A2: Identical odds across states with different ad valorem tax rates

Illinois (35% effective tax rate) **Michigan (8.4% tax rate)**



Notes: DraftKings odds for the Alabama at Michigan men's basketball game, captured at 5:04pm Central on March 27, 2026. The Illinois and Michigan apps display identical moneyline odds (odds on who wins the game) of (−108/−112). The implicit price to wager is approximately 4.5 cents per dollar staked.

Table A3: Promotional Offer Expected Values by Sportsbook.

Sportsbook	Default Offer	Conversion	EV	Deviations from Default
DraftKings	Bet $5, Get $300 bonus bets + $1000 deposit match	$300 × 0.70 + $1000	$1,210	MA, NC: $210 (no deposit match); OR, NH: $0
BetMGM	$1,500 First Bet (risk-free)	$1,500 × 0.50	$750	iGaming (NJ, WV, PA, MI): $150 bonus bets = $105; NV: $250 bonus bets = $175; NY: $0
Fanatics	Bet & Get up to $2,000 in No Sweat Bets	$2,000 × 0.50	$1,000	NY: $0
BetRivers	2nd Chance Bet (risk-free)	× 0.50	varies	$500 (face) → $250 (EV): DE, IL, IN, LA, MD, MI, PA, VA $250 (face) → $125 (EV): CO, NJ $100 (face) → $50 (EV): AZ, IA, NY, OH, WV
FanDuel	Bet $5, Get $250 bonus bets	$250 × 0.70	$175	MO: $210 ($300×0.7)
Caesars	10×$25 profit boosts	$250 × 0.66	$165	(uniform)
Bet365	$1,000 Safety Net (risk-free)	$1,000 × 0.50	$500	iGaming states (NJ, PA): $200 bonus bets × 0.70 = $140

Notes: Conversion rates from DarkHorse Odds [DarkHorse Odds, 2025, The Wall Street Journal, 2024]. Expected values computed as offer amount × conversion rate. Bonus bets convert at 0.70; risk-free/second chance/safety net bets convert at 0.50. iGaming states are NJ, DE, WV, PA, MI, CT. Caesars offers uniform promos across all states and is excluded from Figure 5b. Bet365 offers uniform promos across non-iGaming states but varies promos within iGaming states, so it is included in the main analysis. Figure A3 reports robustness excluding iGaming states. States of operation as of Jan 23, 2026: DraftKings (AZ, CO, CT, DC, IL, IN, IA, KS, KY, LA, MA, ME, MD, MI, MO, NH, NC, NJ, NY, OH, OR, PA, TN, VA, VT, WV, WY); BetMGM (AZ, CO, DC, IN, IA, IL, KS, KY, LA, MA, MD, MI, MO, NC, NJ, NV, NY, OH, PA, TN, VA, WV, WY); Fanatics (AZ, CO, CT, DC, IA, IL, IN, KS, KY, LA, MA, MD, MI, MO, NC, NJ, NY, OH, PA, TN, VA, VT, WV, WY); BetRivers (AZ, CO, DE, IL, IN, IA, LA, MD, MI, NJ, NY, OH, PA, VA, WV); FanDuel (AZ, CO, CT, DC, IL, KS, KY, LA, IN, IA, MA, MD, MI, MO, NC, NJ, NY, OH, PA, TN, VA, VT, WV, WY); Caesars (AZ, CO, DC, IL, IN, IA, KS, KY, LA, MA, MD, ME, MI, MO, NC, NJ, NV, NY, OH, PA, TN, VA, WV); Bet365 (AZ, CO, IA, IL, IN, KS, KY, LA, MD, MO, NC, NJ, OH, PA, TN, VA).

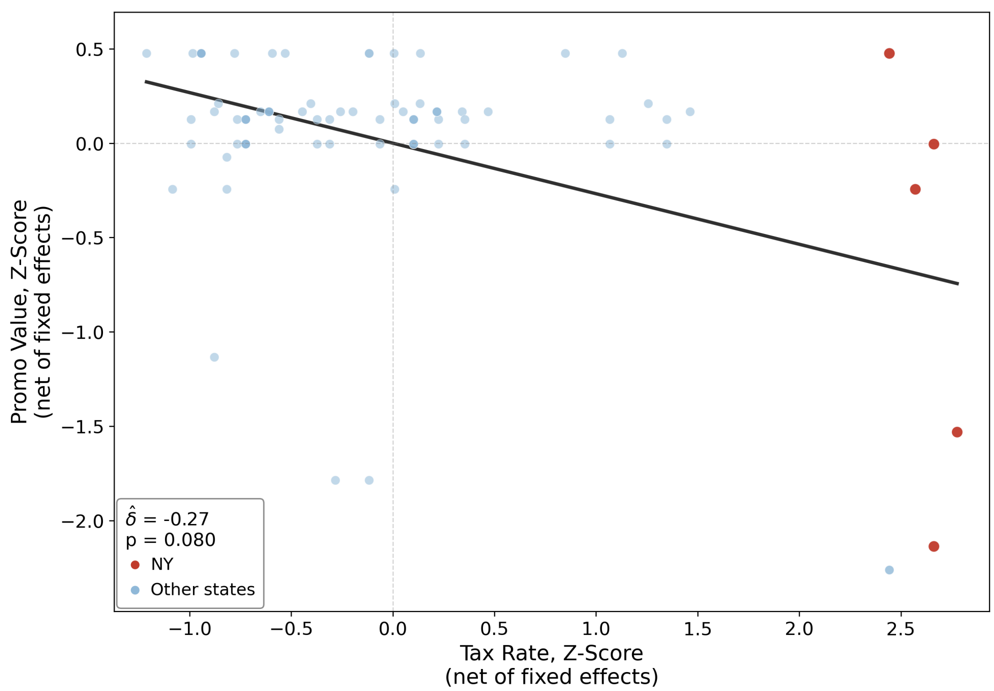
Table A4: Evidence for Uniform Pricing Across States

Sportsbook	**Quote**	**Date**	**Source**
FanDuel	"We can confirm that odds are the same in every state FanDuel operates"	August 2025	Email communication between FanDuel and the authors
BetMGM	"BetMGM offers the same odds in each state. However, there can be differences in the markets we offer. Each state has different regulations on what props they allow."	October 2025	Email communication between BetMGM and the authors
DraftKings, FanDuel	"Neither [DraftKings nor FanDuel] sportsbook employs state-specific odds or pricing, spokespeople with DraftKings and FanDuel confirmed."	September 9, 2024	Legal Sports Report [2024]
DraftKings	"Despite the state's insanely high 51% tax rate, most New York sportsbooks offer the same exact odds and lines featured on their platforms in other states with reasonable rates. For example, any and all odds offered by DraftKings in New York will mirror their offerings available over the bridge in New Jersey. So contrary to popular belief, New York's extraordinary gambling tax isn't going to affect your day-to-day sports betting operations, at all."	October 2025	SportsHandle [2025]
Multiple	"We understand that most US bookmakers use the same sportsbook (same odds) in each state that they operate in."	August 2025	Email communication between staff at odds provider Odds API and the authors
DraftKings	Jason Robins: "If you look at sort of the way it's typically done in other industries, whether it'd be hotel taxes or even the sales tax that you pay when you buy something at the store, taxis, you name it. It's typically line itemed out separately and usually 100% passed along to the consumer. In this case, we're obviously subsidizing a chunk of it. So, we just thought that was most sort of in line with how it's typically done versus trying to obfuscate it..."	Q2 2024	DraftKings [2024a]
DraftKings	[DraftKings CEO] "Robins cautioned DraftKings would likely resort to 'draconian' measures like reducing promotional spend even further and **adding additional juice [higher price to wager a dollar] to bets placed in New York**."	Feb 2023	SBC Americas [2023]
Caesars	For the most part, companies such as Caesars Entertainment and William Hill [since acquired by Caesars] offered identical lines and odds in every jurisdiction	January 2020	ESPN [2020]
DraftKings	Jason Robins: "...tweaking pricing is something you need to consider and some of it will depend on your first question, tax treatment... in terms of other states [besides Illinois], I think we have to see how this one goes...this will be a really interesting experiment to find out what the sort of net effects of implementing such a [state-specific] charge will be. And that will give us great data upon which to rely as we think about other states that may have higher tax rates and what we want to do there."	August 2025	DraftKings [2025b]

Table A5: Sportsbook responses to the Illinois per-wager tax

Strategy	Sportsbook	Details	Source
Full pass-through, all wagers	FanDuel	-	SBC Americas [2025c]
	Caesars	-	SBC Americas [2025b]
	Fanatics	-	Covers.com [2025]
Full pass-through, with exemptions	DraftKings	Applies to singles ≤ $50, parlays < $10	DraftKings [2025a]
	bet365	Applies to wagers < $10	SBC Americas [2025a]
Minimum bet increase	BetMGM	Raised minimum to $2.50	Deadspin [2025]
	BetRivers	Raised minimum to $5	Legal Sports Report [2025a]

Figure A3: Promotional offers vs. tax rates excluding iGaming states



Notes: This replicates the analysis in Figure 5b but excludes the six iGaming states (NJ, DE, WV, PA, MI, CT). N = 85 state-sportsbook pairs across 22 states.

Table A6: Tax → Marketing: Controls

Panel A: Advertising (local TV ad spend per 100 residents on tax rate in p.p.)

	(0)	(1)	(2)	(3)
Tax Rate		−0.550**	−0.412***	−0.453***
Number of Sportsbooks			6.093	4.486
Years Since Legalization				−2.980
Sportsbook-year fixed effects	Y	Y	Y	Y
N	115	115	115	115
R^2	0.38	0.41	0.43	0.44

Panel B: Promos Panel B: Promotional offers (promo value in $ on tax rate in p.p.)

	(0)	(1)	(2)	(3)	(4)	(5)
Tax Rate		−7.698*	−6.755*	−6.796*	−7.011*	−8.363**
NumOperators			39.431	45.562*	45.822*	48.446*
LegalAge				−27.771***	−28.650***	−27.366***
Income ($10k)					8.388	−26.823
Dem Vote Share						4.733
Sportsbook fixed effects	Y	Y	Y	Y	Y	Y
N	124	124	124	124	124	124
R^2	0.67	0.72	0.73	0.75	0.75	0.76

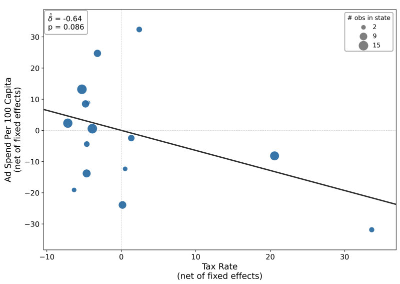
Notes: Panel A regresses local TV ad spending per 100 residents on tax rate, and the sample mirrors Figure 5a and all columns include sportsbook × year fixed effects. Panel B regresses promotional offer value ($) on tax rate, sample mirrors Figure 5b (all legal states; 124 state-sportsbook pairs, 28 states) and all columns include sportsbook fixed effects. p-values use Wild Cluster Bootstrap. Clusters are states.

Table A7: Post-launch ad valorem tax changes and reasons they are not used for within-state identification.

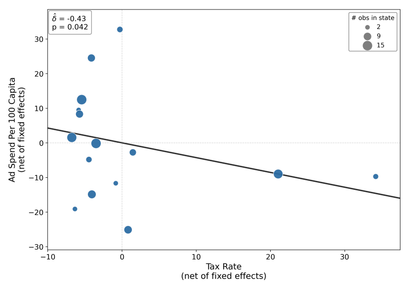
State	Change	Reason not used
Ohio	10% → 20% (7/1/23)	6 months after legalization
Illinois	15% → 20/25/30/35/40% (7/1/24)	No post-2023 ads data
Maryland	15% → 20% (6/1/25)	No post-2023 ads data
Louisiana	15% → 21.5% (8/1/25)	No post-2023 ads data
New Jersey	14.25% → 19.75% (7/1/25)	No post-2023 ads data
D.C.	10% → 10/20/30% (8/1/24)	No post-2023 ads data

Figure A4: Leave-one-state-out: tax rate vs. marketing, dropping each of the highest-tax states

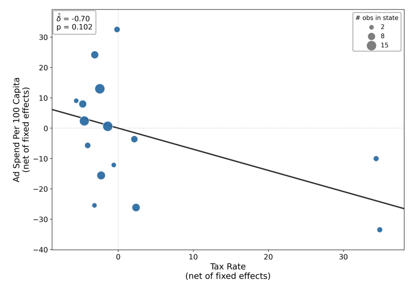
(a) Ads, dropping NY



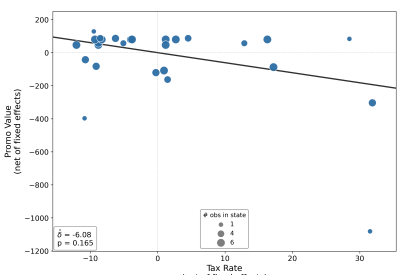
(b) Ads, dropping OR



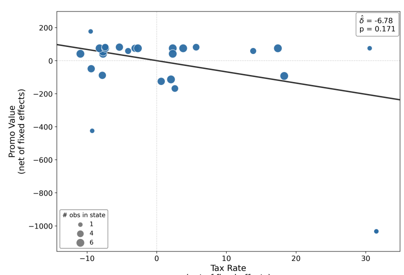
(c) Ads, dropping PA



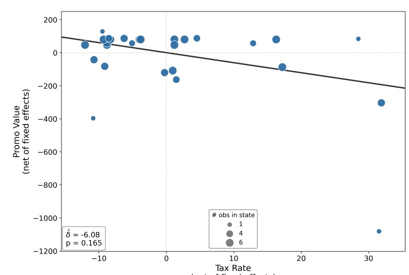
(d) Promos, dropping NH



(e) Promos, dropping NY

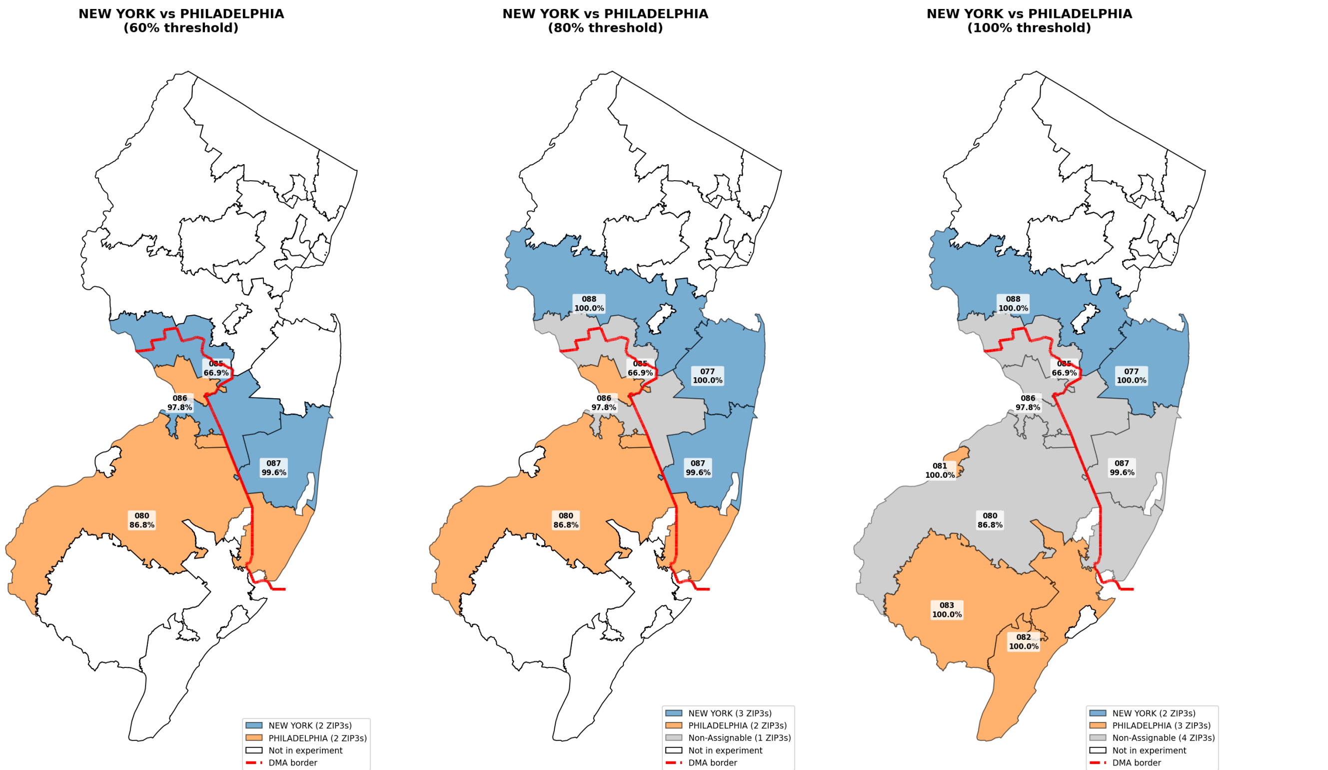


(f) Promos, dropping OR



Notes: Top row replicates Figure 5a after dropping a single high-tax state (NY, OR, or PA, the three highest-tax states in the ad sample). Bottom row replicates Figure 5b after dropping NH, NY, or OR—the three states tied at 51% ad valorem tax in the promo sample. NH is not in the ad sample because there is no DMA which lies entirely in NH. Each dot is a state mean; dot size is proportional to the number of underlying observations. Ad-panel axes are residualized on sportsbook × year fixed effects; promo-panel axes are residualized on sportsbook fixed effects. p-values from wild cluster bootstrap, clustered by state.

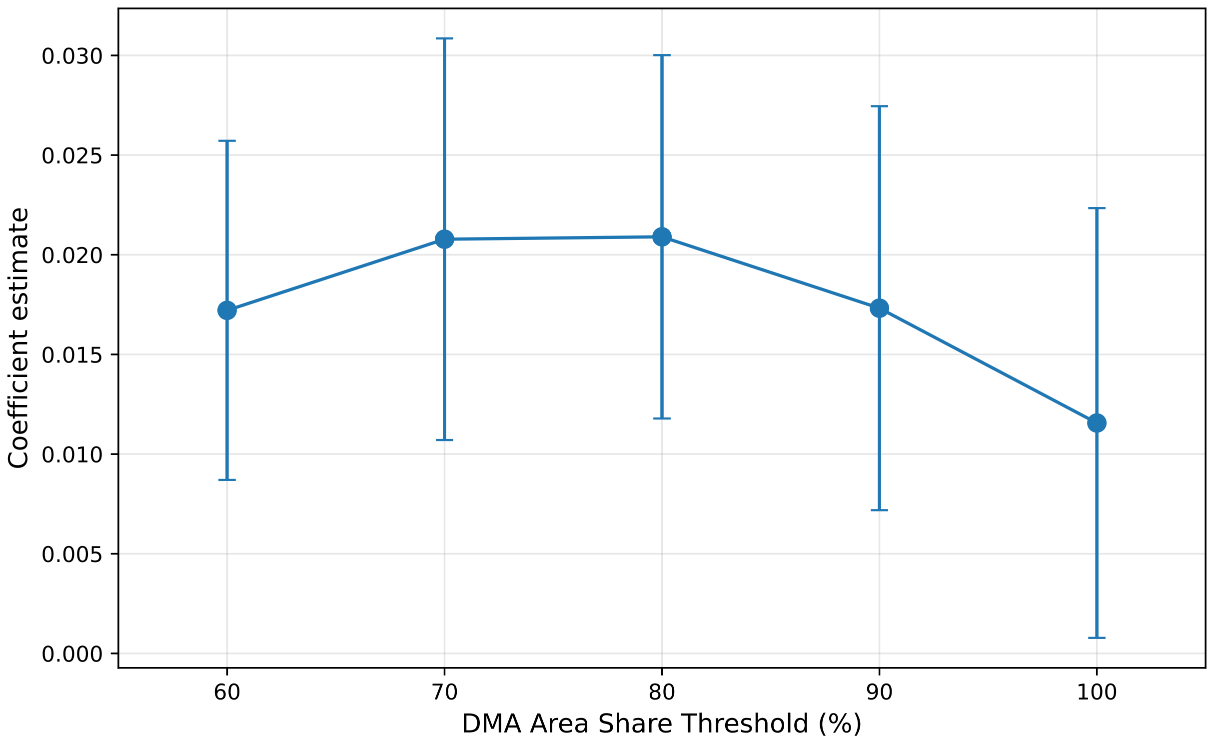
Figure A5: Example of geographies used for the New York DMA / Philadelphia DMA border experiment depending on area-share threshold used



(a) 60% threshold **(b)** 80% threshold **(c)** 100% threshold

Notes: Percentages show the share of each ZIP3's area in its assigned DMA.

Figure A6: Sensitivity of the own-advertising coefficient to the chosen DMA area-share threshold



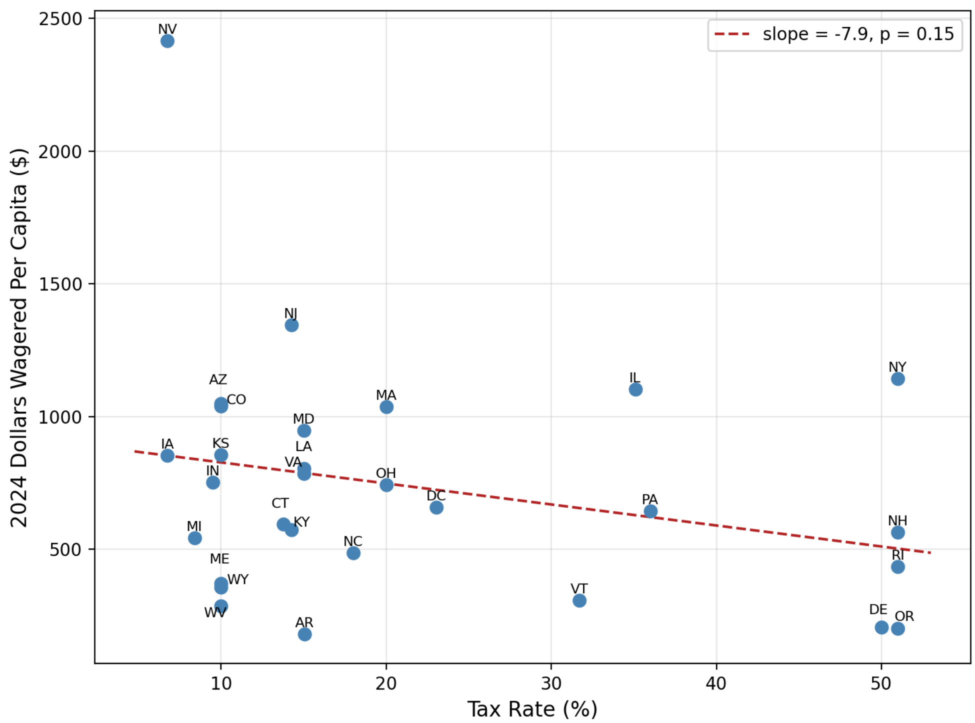
Notes: The figure plots the estimated own advertising coefficient across alternative choices of the DMA area-share threshold. This figure uses Consumer Edge data.

Table A8: Inputs to the chained tax → ads → deposits calculation (1 p.p. tax increase).

#	Quantity	Value	Unit	Source
1	Tax increase, $\Delta\tau$	1	percentage points	Exogenous assumption
2	Tax → ad-spend slope, $\hat{\beta}$	−\$0.55	\$ per 100 residents in single-state DMAs per sportsbook per state-year, per 1 p.p. tax	Section 5, Figure 5a
3	Implied annual \$ change	−\$0.55	\$ per 100 residents in single-state DMAs per sportsbook per state-year	Row 1 × Row 2
4	Implied monthly \$ change	−\$0.046	\$ per 100 residents in single-state DMAs per sportsbook per state-month	Row 3 ÷ 12
5	Per-DMA-month \$ change, Δa^{own}	−\$0.046	\$ per 100 DMA residents per sportsbook per DMA-month	Row 4. The state-level ad spend variable in \$ per capita terms. We assume a sportsbook's per-capita response to a 1 p.p. tax is uniform across DMAs within the state, so we can apply the same state-level slope to every DMA in the state.
6	Mean own ad spend, $\bar{a}^{\text{own}}$	\$3.39	\$ per 100 DMA residents per sportsbook per DMA-month	Population-weighted sample mean of own ads in Table 2 (weighted by DMA population, matching the regression weighting). The unweighted mean reported in the descriptive-statistics table is lower because small DMAs have disproportionately many low-ad observations.
7	Mean rival ad spend (sum over rivals), $\bar{a}^{\text{rival}}$	\$7.98	\$ per 100 DMA residents per DMA-month, summed over all rival sportsbooks	Population-weighted sample mean of rival ads in Table 2
8	Implied rival \$ cut, Δa^{rival}	−\$0.109	\$ per 100 DMA residents per DMA-month, summed over rivals	Row 5 × (Row 7 / Row 6). Each rival faces the same tax and cuts by the same per-capita amount as own, so the rival sum falls by the same proportion
9	Own ad coefficient, $\hat{\gamma}_1$	0.021	log-deposits per \$ per 100 DMA residents per DMA-month	Table 2, col. 1
10	Rival ad coefficient, $\hat{\gamma}_2$	0.018	log-deposits per \$ per 100 DMA residents per DMA-month (rival sum)	Table 2, col. 1
11	Nonlinear coefficients (own^2, rival^2, own×rival), $\hat{\gamma}_3$, $\hat{\gamma}_4$, $\hat{\gamma}_5$	included	log-deposits per (\$ per 100 DMA residents per DMA-month)^2	Table 2, col. 1. Evaluated at post-tax ad levels in the fitted ad-response function
12	$\Delta \ln Q$	−0.0025	log-deposits	Plug Rows 5–11 into the fitted ad-response function below
13	Semi-elasticity, $\Delta Q/Q$ per 1 p.p. tax	−0.25%	percent per percentage point	exp(Row 12) − 1
14	Mean state tax rate, $\bar{\tau}$	21%	percent	Sample mean of state ad valorem tax rates in the state-level tax–ads regression (Section 5)
15	Elasticity, $\varepsilon_{Q,\tau}$	−0.053	% change in deposits per % change in tax rate	Row 13 × Row 14 /100

Notes: This table uses Consumer Edge data.

Figure A7: Reduced-form relationship between dollars wagered per capita and tax rates



Each point is a state. Dollars wagered per capita are for 2024.

Table A9: Inputs to the industry-advertising semi-elasticity $s^D_{Q,A}$.

#	Quantity	Value	Unit	Source
1	Own ad coefficient, $\hat{\gamma}_1$	0.02090	log-deposits per \$ per 100 DMA residents per DMA-month	Table 2, col. 1
2	Rival ad coefficient, $\hat{\gamma}_2$	0.01813	log-deposits per \$ per 100 DMA residents per DMA-month (rival sum)	Table 2, col. 1
3	Own^2 coefficient, $\hat{\gamma}_3$	−0.00036	log-deposits per (\$ per 100 DMA residents per DMA-month)^2	Table 2, col. 1
4	Rival^2 coefficient, $\hat{\gamma}_4$	−0.00020	log-deposits per (\$ per 100 DMA residents per DMA-month)^2	Table 2, col. 1
5	Own × rival coefficient, $\hat{\gamma}_5$	0.00002	log-deposits per (\$ per 100 DMA residents per DMA-month)^2	Table 2, col. 1
6	Mean own ad spend, $\bar{a}^{\text{own}}$	\$3.39	\$ per 100 DMA residents per sportsbook per DMA-month	Population-weighted sample mean (Table 2)
7	Mean rival ad spend, $\bar{a}^{\text{rival}}$	\$7.98	\$ per 100 DMA residents per DMA-month, summed over rivals	Population-weighted sample mean (Table 2)
8	Own marginal effect, $\partial \ln Q/\partial a^{\text{own}} = \hat{\gamma}_1 + 2\hat{\gamma}_3\bar{a}^{\text{own}} + \hat{\gamma}_5\bar{a}^{\text{rival}}$	0.01862	log-deposits per \$ per 100 DMA residents per DMA-month	Rows 1, 3, 5, 6, 7
9	Rival marginal effect, $\partial \ln Q/\partial a^{\text{rival}} = \hat{\gamma}_2 + 2\hat{\gamma}_4\bar{a}^{\text{rival}} + \hat{\gamma}_5\bar{a}^{\text{own}}$	0.01501	log-deposits per \$ per 100 DMA residents per DMA-month	Rows 2, 4, 5, 6, 7
10	Lockstep ratio, $\bar{a}^{\text{rival}}/\bar{a}^{\text{own}}$	2.354	unitless	Row 7 ÷ Row 6
11	Own-channel contribution, 100× Row 8	1.862	% \$ wagered per (\$1 ad/100 capita per month, all firms)	Row 8 ×100
12	Rival-channel contribution, 100× Row 10 × Row 9	3.532	% \$ wagered per (\$1 ad/100 capita per month, all firms)	Rows 9, 10 ×100
13	Semi-elasticity, $s^D_{Q,A}$	5.39	% \$ wagered per (\$1 ad/100 capita per month, all firms)	Row 11 + Row 12

Notes: Advertising is measured per firm; dollars wagered is the industry total. Derived entries are computed at full precision, so displayed rows need not multiply exactly.

Table A10: Descriptive Statistics: Advertising and Deposits

Ad spend ($/100 capita)	
Mean	2.612
Std Dev	5.409
Median	0.024
25th Percentile	0.000
75th Percentile	2.525
Deposits ($)	
Mean	68,914
Std Dev	226,678
Median	15,267
25th Percentile	4,061
75th Percentile	47,549
Observations	12,850
Border experiments	135
DMAs	89
Sportsbooks	5

Notes: Observation: side × sportsbook × month. Ad spend in $/100 capita in DMA. Deposits in $. This table uses Consumer Edge data.

Table A11: Composition of above- and below-median advertising halves for Section 6.4

	Below median	Above median
Sportsbook		
DraftKings	57%	58%
FanDuel	37%	33%
Caesars	1%	3%
BetRivers	3%	2%
Bet365	2%	3%
Cohort year		
2018	1%	0%
2019	4%	5%
2020	9%	9%
2021	19%	20%
2022	40%	33%
2023	28%	33%

Notes: This table uses Consumer Edge data.

Table A12: Advertising Semi-Elasticity Estimates with Lagged Advertising

		Customers		Dep./Customer	
	Deposits (1)	New (2)	Existing (3)	New (4)	Existing (5)
$\ln Y_{j,m,t-1}$	0.34730***	0.12313***	0.39809***	−0.14113***	0.27072***
	(0.02451)	(0.02367)	(0.02760)	(0.01773)	(0.02627)
Own	0.02169***	0.04985***	0.02326***	−0.00662	0.00065
	(0.00505)	(0.00791)	(0.00350)	(0.00746)	(0.00440)
Own Lag (t-1)	0.00023	0.00631**	−0.00081	0.00120	−0.00117
	(0.00201)	(0.00249)	(0.00134)	(0.00343)	(0.00198)
Own^2	−0.00040***	−0.00106***	−0.00040***	0.00023	0.00005
	(0.00014)	(0.00022)	(0.00007)	(0.00017)	(0.00009)
Rival	0.01848***	0.02580***	0.01578***	0.00005	0.00258
	(0.00313)	(0.00364)	(0.00292)	(0.00449)	(0.00286)
Rival Lag (t-1)	0.00230*	0.00117	0.00159*	−0.00203	0.00233*
	(0.00118)	(0.00162)	(0.00088)	(0.00235)	(0.00137)
Rival^2	−0.00021***	−0.00026***	−0.00022***	0.00006	−0.00002
	(0.00006)	(0.00007)	(0.00007)	(0.00006)	(0.00005)
Own × Rival	0.00004	0.00001	0.00001	−0.00011	−0.00007
	(0.00017)	(0.00017)	(0.00014)	(0.00020)	(0.00015)
SB × Border × DMA FE	Yes	Yes	Yes	Yes	Yes
SB × Border × Quarter FE	Yes	Yes	Yes	Yes	Yes
Observations	12,382	12,382	12,382	12,382	12,382
R^2	0.938	0.867	0.966	0.515	0.806

Notes: Sportsbook × DMA clustered standard errors in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. Column (1) pools all depositors. Columns (2)–(5): "New" = first deposit at that sportsbook in that calendar month. Border experiments restricted to quarters in which sports betting is legal and to ZIP3s where a majority of the population resides in one state. This table uses Consumer Edge data.

Table A13: Advertising Semi-Elasticity: Allowing Cross-State Border Experiments

		Customers		Dep./Customer	
	Deposits	New	Existing	New	Existing
	(1)	(2)	(3)	(4)	(5)
$\ln Y_{j,m,t-1}$	0.38854***	0.17055***	0.43771***	−0.07493***	0.30338***
	(0.02435)	(0.02374)	(0.03048)	(0.02005)	(0.02682)
Own	0.02303***	0.05580***	0.02223***	−0.00665	0.00101
	(0.00478)	(0.00795)	(0.00330)	(0.00704)	(0.00395)
Rival	0.01435***	0.02853***	0.01477***	−0.00390	−0.00032
	(0.00291)	(0.00388)	(0.00229)	(0.00468)	(0.00269)
Own^2	−0.00043***	−0.00114***	−0.00039***	0.00025*	−0.00000
	(0.00012)	(0.00019)	(0.00006)	(0.00015)	(0.00010)
Rival^2	−0.00016***	−0.00030***	−0.00019***	0.00011	−0.00000
	(0.00006)	(0.00008)	(0.00005)	(0.00008)	(0.00006)
Own × Rival	0.00007	−0.00008	0.00006	−0.00022	0.00005
	(0.00017)	(0.00018)	(0.00012)	(0.00024)	(0.00017)
SB × Border × DMA FE	Yes	Yes	Yes	Yes	Yes
SB × Border × Quarter FE	Yes	Yes	Yes	Yes	Yes
Observations	14,454	14,454	14,454	14,454	14,454
R^2	0.939	0.867	0.966	0.518	0.814

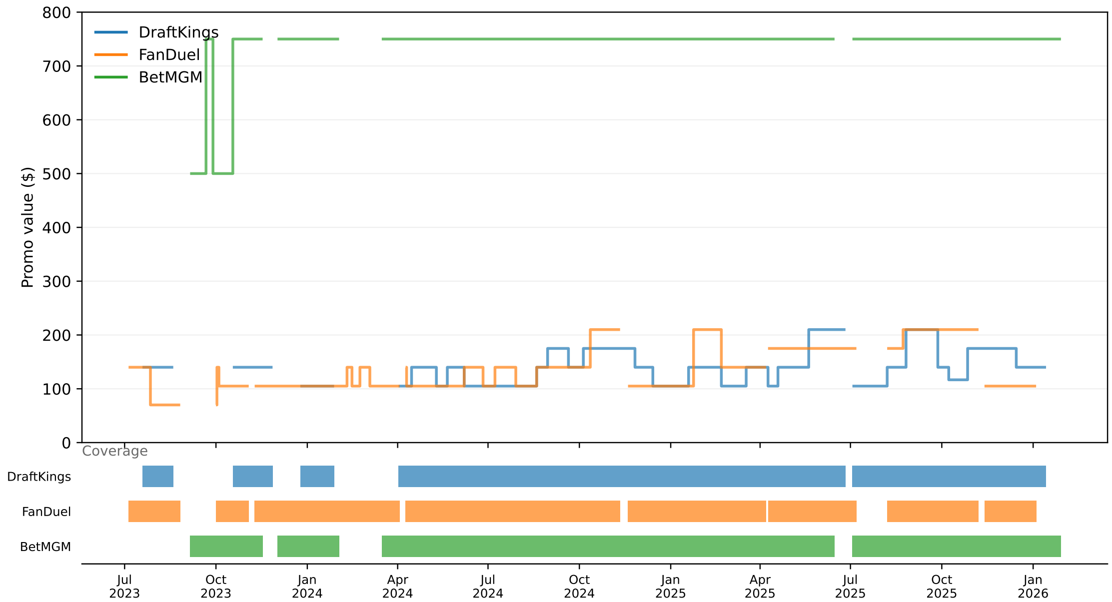
Notes: Sportsbook × DMA clustered standard errors in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. Column (1) pools all depositors. Columns (2)–(5): "New" = first deposit at that sportsbook in that calendar month. Border experiments restricted to legal quarters but cross-state borders allowed. This table uses Consumer Edge data.

Table A14: Advertising Semi-Elasticity: DraftKings and FanDuel Only

		Customers		Dep./Customer	
	Deposits	New	Existing	New	Existing
	(1)	(2)	(3)	(4)	(5)
$\ln Y_{j,m,t-1}$	0.36455***	0.16641***	0.42650***	−0.12830***	0.27623***
	(0.02792)	(0.02619)	(0.03063)	(0.01947)	(0.03094)
Own	0.02115***	0.05662***	0.02536***	−0.00549	−0.00334
	(0.00483)	(0.00720)	(0.00327)	(0.00684)	(0.00409)
Rival	0.02506***	0.03896***	0.02677***	−0.00594	0.00312
	(0.00414)	(0.00624)	(0.00454)	(0.00657)	(0.00403)
Own^2	−0.00031***	−0.00094***	−0.00032***	0.00007	0.00008
	(0.00012)	(0.00020)	(0.00007)	(0.00016)	(0.00009)
Rival^2	−0.00041***	−0.00039***	−0.00046***	0.00001	−0.00010
	(0.00011)	(0.00012)	(0.00015)	(0.00011)	(0.00009)
Own × Rival	−0.00014	−0.00069***	−0.00038*	0.00035	0.00013
	(0.00023)	(0.00025)	(0.00021)	(0.00027)	(0.00021)
SB × Border × DMA FE	Yes	Yes	Yes	Yes	Yes
SB × Border × Quarter FE	Yes	Yes	Yes	Yes	Yes
Observations	10,836	10,836	10,836	10,836	10,836
R^2	0.942	0.864	0.964	0.484	0.791

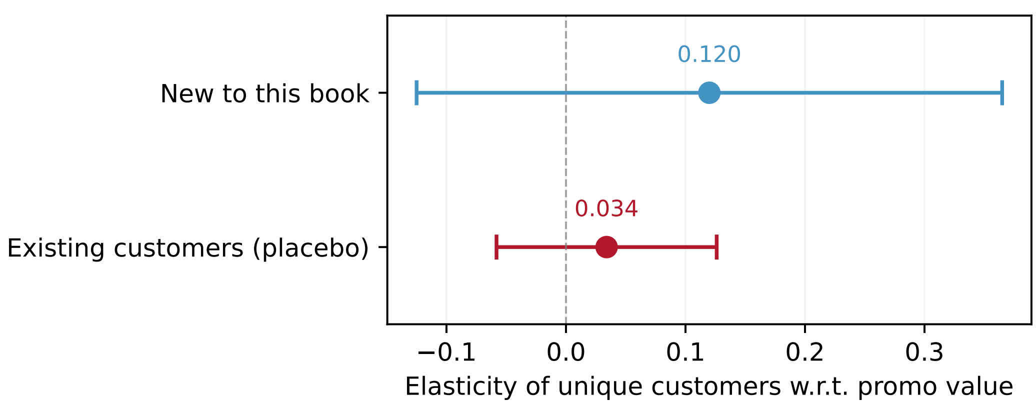
Notes: Sportsbook × DMA clustered standard errors in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. Column (1) pools all depositors. Columns (2)–(5): "New" = first deposit at that sportsbook in that calendar month. Border experiments restricted to quarters in which sports betting is legal and to ZIP3s where a majority of the population resides in one state. This table uses Consumer Edge data.

Figure A8: Promotional sign-up offer values over time for DraftKings, FanDuel, and BetMGM



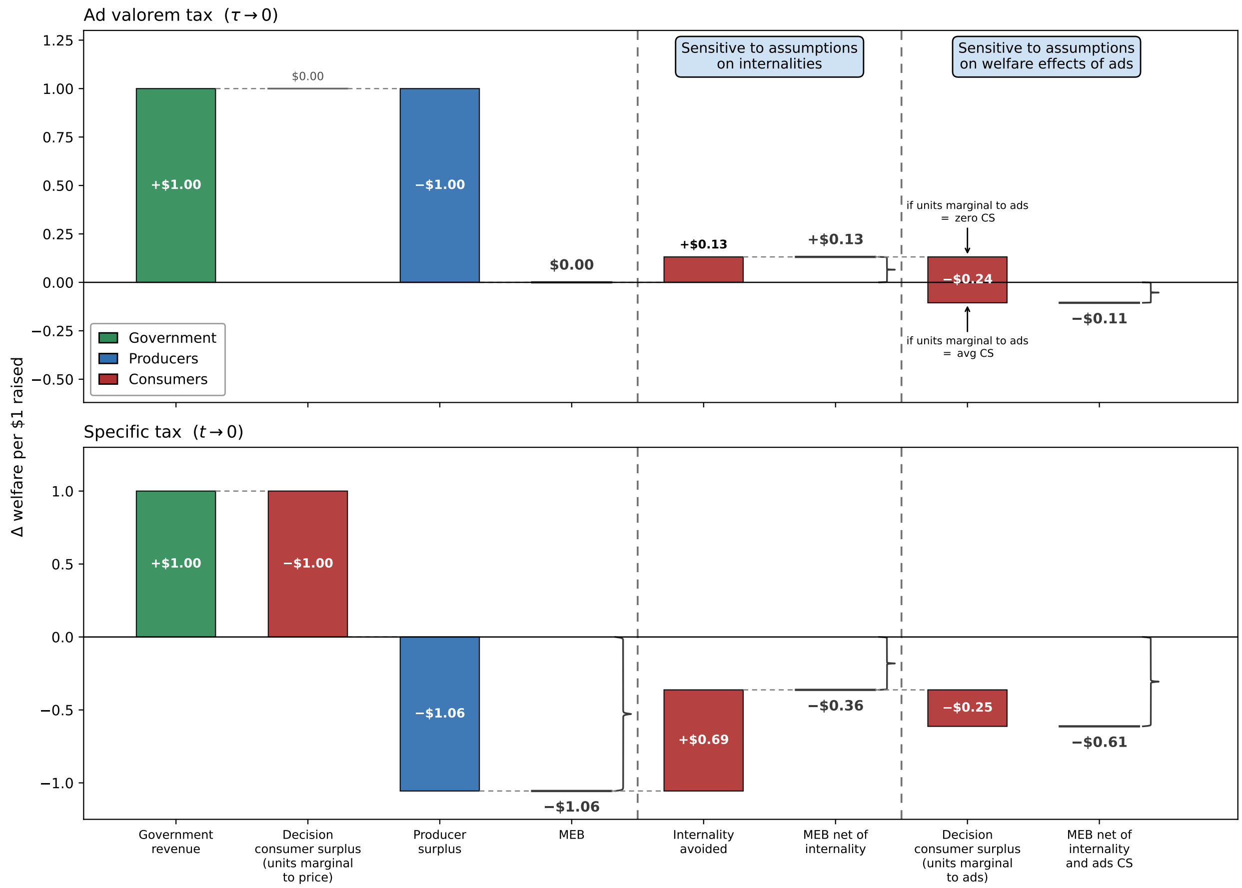
Notes: All offers are converted to expected value in dollars. Values are extracted from Internet Archive snapshots of Action Network pages. When snapshots are missing between days, we carry forward promo values for 30 days, or until the next snapshot in the Internet Archive, whichever comes first. The bottom panel shows coverage windows.

Figure A9: Elasticity of unique depositors with respect to promotional offer value, by population



Notes: New-to-book depositors have no prior deposit at that sportsbook; existing customers have deposited before and serve as a placebo. The figure shows 95% confidence intervals. Regressions include book and month fixed effects, with Driscoll–Kraay standard errors (lag = 4). N = 331 (125 weeks × 3 books). This figure uses Consumer Edge data.

Figure A10: Incidence and efficiency of the first dollar of an ad valorem tax and a specific tax



Notes: Replicates Figure 7, but evaluates each instrument at an initial rate of zero ($\tau \to 0$ and $t \to 0$) instead of the U.S.-average ad valorem rate and the revenue-equivalent specific rate. Each panel shows the marginal excess burden of the first dollar of revenue raised by that instrument. Calibrated parameters and MEB formulae are as in Figure 7.

B Data Appendix

B.1 Sample Construction

B.1.1 Sample Construction for Advertising-Tax Correlation (Figure 5a)

From the seven major sportsbooks, we use five sportsbooks for this analysis: DraftKings, FanDuel, Caesars, BetRivers, and bet365. We drop two: Fanatics only entered the market in 2023, and only advertised in multi-state DMAs (Boston and Washington DC), so Fanatics is dropped. BetMGM's ads for online casino vs. sports betting are indistinguishable in the Nielsen data, so BetMGM is dropped.

Among the five sportsbooks in this analysis, we remove advertisements whose brand description contains "fantasy" (to exclude daily fantasy sports) and keep only those containing "sports."

Starting from the 29 states (including Washington, DC) with legal online sports betting at the end of 2023 (when the Nielsen data ends), we apply the following filters:

1. **No major sportsbooks operate there (3 states) or the state has no ad valorem tax (1 state).** This is the same reasoning described in Section B.1.3. We drop Arkansas, Rhode Island, and Florida, where none of the sportsbooks in our sample operate. We drop Tennessee, which taxes dollars wagered rather than revenue.

2. **No county-level Nielsen DMA coverage (1 state).** We drop Connecticut, which has planning regions instead of counties. Counties are used to define the Nielsen DMA regions, so we cannot reliably calculate the population of the DMA for Connecticut DMAs.

3. **Multi-state DMAs (3 states).** Our variation is at the state level, so we keep only Nielsen DMAs that lie entirely within one state. This drops all DMAs from New Jersey, the District of Columbia, and New Hampshire.

4. **Legalized during 2023 (5 states).** We include a state-year observation only if the state legalized by December 31 of the prior year. States that legalized during 2023 (Ohio, Massachusetts, Kentucky, Maine, Delaware) are entirely excluded.

Table B1 reports the yearly share of the legal-state sample dropped because the physical DMA crosses state borders.

Table B1: Percent dropped because DMAs cross state borders in the advertising-tax sample

Year	Dropped / total legal-state DMA pieces	Percent by DMA	Percent by population
2019	13 / 15	86.7%	81.2%
2020	42 / 54	77.8%	68.2%
2021	52 / 69	75.4%	72.7%
2022	73 / 101	72.3%	59.6%
2023	90 / 129	69.8%	63.1%
Pooled 2019–2023	270 / 368	73.4%	65.4%

Notes: This table uses the exact yearly sample rule for Panel (a) of Figure 5: a state-year is eligible only if online sports betting was legal by December 31 of the prior year, after applying the ad-spend exclusions for Arkansas, Connecticut, Florida, Rhode Island, and Tennessee. "By DMA" counts legal-state DMA pieces, since the regression sample is built from state pieces of DMAs before aggregation to the state-sportsbook-year level. "By population" weights those same pieces by eligible legal-state population inside each DMA. The pooled row sums dropped and total pieces (and populations) across all state-years in the 2019–2023 regression sample, so it overweights states that are legal earlier — mirroring the weighting implicit in the regression itself.

B.1.2 Sample Construction for Advertising-Deposit Elasticity Analysis (Table 2)

Constructing border experiments. Unlike counties, ZIP3s do not align with DMA boundaries (Figure A5). For each ZIP3 intersected by a DMA boundary:

1. If ≥80% of its area lies in one DMA, it joins that DMA-side (e.g., ZIP3 080 in Figure A5b). Adjacent ZIP3s with ≥80% of their area in the other DMA form the other side.

2. If <80% lies in any single DMA, the ZIP3 is dropped (e.g., ZIP3 085 in Figure A5b). Adjacent ZIP3s on either side of the border that meet the 80% threshold are added.

This procedure creates a gap between the two sides of each border experiment. The median experiment has a 13-mile gap between the nearest edges of opposing ZIP3s. Figure A5 illustrates how the experiment changes under alternative thresholds: stricter thresholds retain fewer ZIP3s near the border. Figure A6 shows how our coefficient on own-advertising changes as we vary this threshold choice.

Other sample restrictions.

1. We drop BetMGM because we cannot distinguish between ads for online casino and online sports betting in the Nielsen data.

2. We restrict to states where at least one major sportsbook operates, dropping RI, FL, and AR.

3. Sports betting is regulated at the state level, so we drop cross-state variation. If a DMA border coincides with a state border, we drop the experiment. If a border-side spans states, we keep only ZIP3s from whichever state has the most ZIP3s on that border-side.

4. We drop observations when sports betting was illegal in a state, only including post-legalization months for states that eventually legalized, and dropping states that didn't legalize sports betting during our sample period.

5. After the above restrictions, the balanced side-sportsbook-month sample contains 40,782 observations. Of these, 15,057 (36.9%) have zero deposits and are dropped because we estimate $\log(Q)$.

B.1.3 Sample Construction for Promotional Analyses

Our sample includes 28 states (including Washington, DC). From the 32 states (including Washington, DC) with legal online sports betting, we drop 4 for data limitations.

None of the sportsbooks in our sample operate (3 states): We drop three states because none of the sportsbooks in our sample operate there. We drop Florida, where the only legal online sportsbook is Hard Rock Bet (Seminole Tribe).[24] We drop Rhode Island (served only by Sportsbook Rhode Island) and Arkansas. Arkansas' regulations require licensees to retain 51% of net sports-betting revenue in any market-access agreement with a third-party operator, which discourages national operators.

No ad valorem tax (1 state): We drop Tennessee, which taxes dollars wagered rather than revenue.

Robustness check: Drop iGaming states: Six states have legal online casino (iGaming): New Jersey, Delaware, West Virginia, Pennsylvania, Michigan, and Connecticut. During a conversation with an employee at DarkHorse Odds, they mentioned that sportsbooks set promotional offers for iGaming states separately. Firms vary promos in these states primarily based on whether a state has legal iGaming, rather than the state's tax rate. Firms appear to operate as if they have a fixed promotional budget per potential customer, which they divide between sportsbook and iGaming offers. For example, as of October 2025, BetMGM was offering a $1,000 iGaming sign-up bonus to residents in the four iGaming states it operates in, but offered its lowest sports betting promotional offers in these same states [BetMGM, 2025]. We include these states in the main analysis. As a robustness check, Figure A3 excludes them and estimates $\hat{\beta} = -0.27$ ($p = 0.08$).

[24] Hard Rock Bet is the only legal online betting app in Florida [Legal Sports Report, 2025b].

B.2 Consumer Edge Benchmarking

This appendix benchmarks the Consumer Edge data.

Figure B1 plots monthly sportsbook deposits by Consumer Edge cards billed to New York ZIP3s. Deposits spike sharply at New York's January 2022 legalization, demonstrating that the Consumer Edge data captures state-level legalization events.

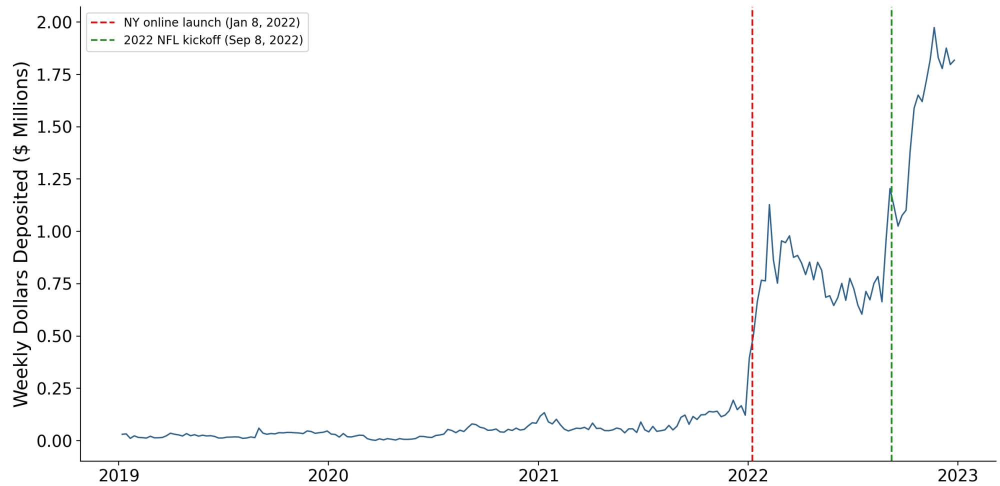


Figure B1: Deposits by New York cards to sportsbooks spike after legalization

Notes: This figure uses Consumer Edge data.

Figure B2 plots Consumer Edge deposits against administrative revenue across 25 states. The cross-state correlation is 0.85, and Consumer Edge deposits represent 9.2% of aggregate revenue.

Figure B3 plots quarterly Consumer Edge sportsbook deposits against quarterly aggregate revenue reported by state regulators. The two series move closely together over the sample, with a quarterly log correlation of 0.97.

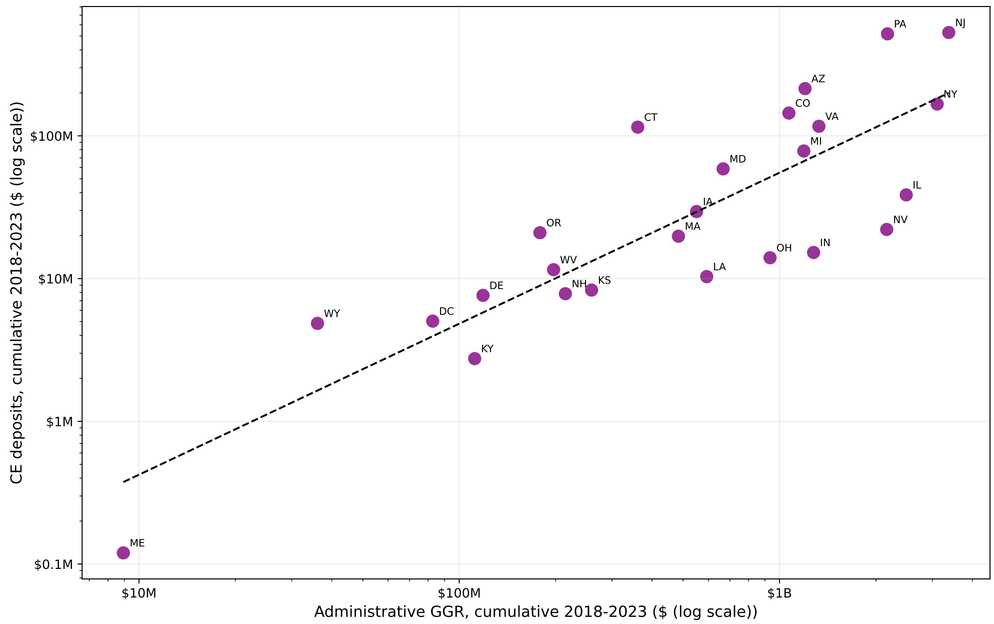


Figure B2: Consumer Edge deposits vs. administrative revenue across states

Notes: Each point is a state. Both axes in logs. Log correlation = 0.85. Consumer Edge deposits are 9.2% of aggregate revenue.

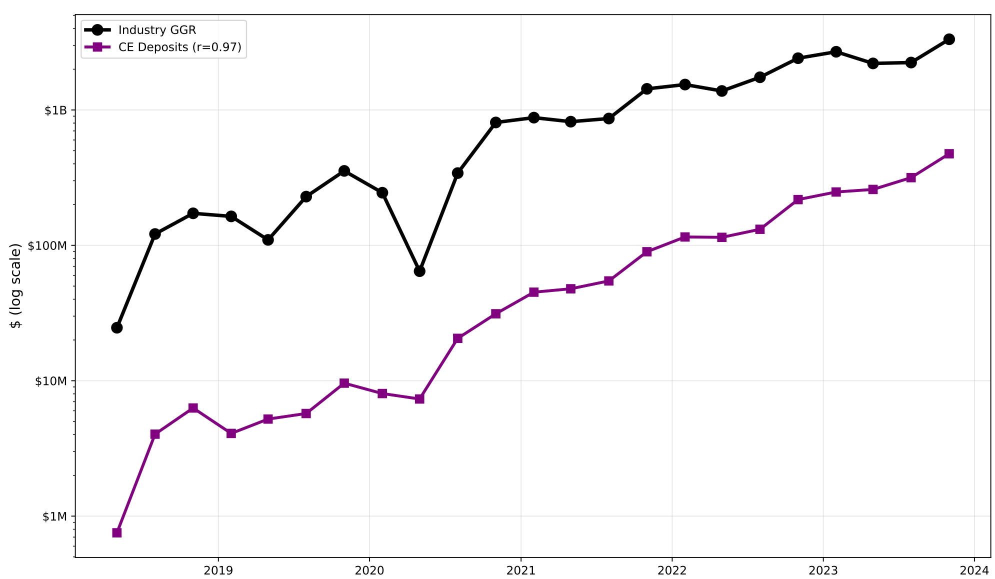


Figure B3: Consumer Edge deposits vs. administrative revenue over time

Notes: Quarterly aggregates. Both series in logs. Log correlation = 0.97.

C Proofs Appendix

C.1 Proof of Proposition 1

Proof. The pricing first-order condition is independent of τ (see main text). For advertising, the symmetric equilibrium first-order condition is

$$(1-\tau)\,p^*(\theta)\,\frac{\partial Q_i}{\partial A_i}(A^*) = c'(A^*).$$

Implicitly differentiating with respect to τ:

$$\frac{dA^*}{d\tau} = \frac{p^*(\theta)\,\frac{\partial Q_i}{\partial A_i}(A^*)}{(1-\tau)\,p^*(\theta)\,\frac{\partial^2 Q_i}{\partial A_i^2}(A^*) - c''(A^*)}.$$

The numerator is positive since $\partial Q_i/\partial A_i > 0$ and $p^*(\theta) > 0$. The denominator is strictly negative: $c''(A^*) > 0$ by the convexity assumption on advertising costs, and $(1-\tau)\,p^*(\theta)\,\partial^2 Q_i/\partial A_i^2 \leq 0$ by the industry-level diminishing returns assumption. Hence $dA^*/d\tau < 0$. □

C.2 Optimal price under positive marginal cost

Proof. With marginal cost $\kappa > 0$, the symmetric pricing first-order condition under conduct θ is

$$G(p) \;\equiv\; \theta\,Q(p) + \big[p - \kappa/(1-\tau)\big]Q'(p) \;=\; 0$$

Implicit differentiation with respect to τ gives

$$\frac{dp^*}{d\tau} \;=\; -\frac{G_\tau}{G_p} \;=\; -\frac{-\kappa\,Q'(p^*)/(1-\tau)^2}{G_p}.$$

The numerator $G_\tau = -\kappa\,Q'(p^*)/(1-\tau)^2$ is strictly positive since $Q'(p^*) < 0$. The denominator G_p is the second-order condition of the firm's pricing problem and is strictly negative at any interior maximum. Hence $dp^*/d\tau > 0$. □

C.3 Specific tax reduces advertising

Proof. Recall, we assumed multiplicative separability $Q(p, A) = f(p)\,g(A)$ with $f' < 0$ and $g' > 0$. Let t denote the specific tax per dollar wagered and $\rho \equiv dp^*/dt \in [0, 1]$ the equilibrium pass-through rate. The symmetric advertising first-order condition is

$$[p^*(t) - t]\,f(p^*(t))\,g'(A^*) = c'(A^*).$$

Implicit differentiation with respect to t yields

$$\frac{dA^*}{dt} = \frac{g'(A^*)\big[\underbrace{-(1-\rho)\,f(p^*)}_{\text{margin channel}} + \underbrace{\rho\,(p^*-t)\,f'(p^*)}_{\text{price channel}}\big]}{c''(A^*) - (p^*-t)\,f(p^*)\,g''(A^*)}.$$

The margin term is non-positive (strict for $\rho < 1$) since $f > 0$. The price term is non-positive (strict for $\rho > 0$) since $f' < 0$ and the post-tax margin $p^* - t > 0$ at any interior optimum. At least one term is strictly negative for any $\rho \in [0, 1]$, so the numerator is strictly negative. The denominator is strictly positive: $c''(A^*) > 0$ by convex advertising costs, and $-(p^* - t)\,f(p^*)\,g''(A^*) \geq 0$ by diminishing returns to advertising ($g'' \leq 0$). Hence $dA^*/dt < 0$. □

C.4 Proof of Proposition 2

We prove Proposition 2 under Assumptions 1–4, maintaining the model of Section 3: multiplicative separability $Q(p, A) = f(p)\,g(A)$, zero marginal cost ($MC = 0$), and an interior optimum at (p^*, A^*). Semi-elasticities are positive by convention: $\eta_j^P \equiv -\frac{1}{Q}\frac{\partial Q}{\partial p}\frac{dp}{dj} \geq 0$ and $\eta_j^A \equiv -\frac{1}{Q}\frac{\partial Q}{\partial A}\frac{dA}{dj} \geq 0$, so $\frac{dQ}{dj} = -Q\,\eta_j^{Tot}$ where $\eta_j^{Tot} = \eta_j^P + \eta_j^A$. The firm's per-unit profit is $m = p - z_j$ (price minus per-unit tax, with $MC = 0$). All four formulas share the same denominator, which equals revenue change per unit of Q:

$$\frac{dR/dj}{Q} = \omega_j - z_j\,\eta_j^{Tot},$$

since $R = z_j Q$ gives $dR/dj = \omega_j Q + z_j\,dQ/dj = Q\,(\omega_j - z_j\,\eta_j^{Tot})$.

Item 1 (Decision consumer surplus). By quasilinear preferences (Assumption 1), $\partial DCS/\partial p = -Q$, so the price channel contributes $-\frac{dp}{dj}\,Q$ to $dDCS/dj$. By Assumption 4, ads only affect welfare through Q; each ad-marginal unit carries $DCS/Q = 1/s_{Q,P}^D$ of consumer surplus (the constant semi-elasticity $f(p) = c\,e^{-s_{Q,P}^D p}$ implies $DCS/Q = 1/s_{Q,P}^D$; see footnote in Section 7). Units lost through the ad channel total $Q\,\eta_j^A$, contributing $-Q\,\eta_j^A/s_{Q,P}^D$. Hence

$$\frac{dDCS}{dj} = -Q\left(\frac{dp}{dj} + \frac{\eta_j^A}{s_{Q,P}^D}\right).$$

Dividing by $dR/dj = Q\,(\omega_j - z_j\,\eta_j^{Tot})$ gives equation (7). □

Item 2 (Producer surplus). With $MC = 0$, $PS = m\,Q - c(A)$ where $m = p - z_j$. Differentiating:

$$\frac{dPS}{dj} = \underbrace{\left(\frac{dp}{dj} - \omega_j\right) Q}_{\text{change in per-unit profit}} + \underbrace{m\,\frac{dQ}{dj}}_{\text{extensive margin}} \underbrace{- c'(A)\,\frac{dA}{dj}}_{\text{ad cost}}.$$

The firm's advertising FOC gives $c'(A) = m\,\frac{\partial Q}{\partial A}$, so $c'(A)\,\frac{dA}{dj} = m\,\frac{\partial Q}{\partial A}\,\frac{dA}{dj} = -m\,Q\,\eta_j^A$. Substituting and using $m\,\frac{dQ}{dj} = -m\,Q\,\eta_j^{Tot}$:

$$\frac{dPS}{dj} = \left(\frac{dp}{dj} - \omega_j\right) Q - m\,Q\,\eta_j^{Tot} + m\,Q\,\eta_j^A = Q\left[\left(\frac{dp}{dj} - \omega_j\right) - m\,\eta_j^P\right].$$

Dividing by dR/dj gives equation (8). □

Item 3 (Internalities). $\frac{d(-\zeta Q)}{dj} = -\zeta\,\frac{dQ}{dj} = \zeta\,Q\,\eta_j^{Tot}$. Dividing by dR/dj gives the third formula in Proposition 2. □

Item 4 (Marginal excess burden). Total welfare is $W = DCS + PS + R - \zeta Q$. Summing the four welfare components per unit of Q:

$$\frac{dW/dj}{Q} = \underbrace{-\frac{dp}{dj} - \frac{\eta_j^A}{s_{Q,P}^D}}_{\text{DCS}} + \underbrace{\frac{dp}{dj} - \omega_j - m\,\eta_j^P}_{\text{PS}} + \underbrace{\omega_j - z_j\,\eta_j^{Tot}}_{\text{Revenue}} + \underbrace{\zeta\,\eta_j^{Tot}}_{\text{Internality}}.$$

The $\frac{dp}{dj}$ terms cancel (transfer between consumers and firms) and the ω_j terms cancel (transfer between firms and government), leaving

$$\frac{dW/dj}{Q} = -z_j\,\eta_j^{Tot} - \frac{\eta_j^A}{s_{Q,P}^D} - m\,\eta_j^P + \zeta\,\eta_j^{Tot}.$$

Dividing by $(\omega_j - z_j\,\eta_j^{Tot})$ gives equation (10). □

C.5 Lemmas for implementing calibration

The following two lemmas provide the specific-tax inputs needed to evaluate equation (10) for $j = t$. With $f(p) = c\,e^{-s_{Q,P}^D p}$ (Assumption 3, so $f'(p) = -s_{Q,P}^D\,f(p)$), the symmetric-equilibrium first-order conditions under conduct parameter θ are:

$$(p-t)\,f'(p)+\theta\,f(p)=0 \tag{P}$$
$$(p-t)\,f(p)\,g'(A)=c'(A) \tag{A}$$

Lemma 1 (pass-through). Claim. The specific tax satisfies $dp/dt=1$, $p(t)-t=p^*$, $m=p^*$, and $\eta_t^P=s_{Q,P}^D$.

Proof.

$$\begin{aligned}
(p-t)\,f'(p)+\theta\,f(p)&=0 && \text{[FOC (P)]}\\
-(p-t)\,s_{Q,P}^D\,f(p)+\theta\,f(p)&=0 && [f'=-s_{Q,P}^D f,\ \text{Assumption 3}]\\
(p-t)\,s_{Q,P}^D&=\theta && [\text{divide by } f(p)>0]\\
p(t)&=t+\theta/s_{Q,P}^D
\end{aligned}$$

So $dp/dt=1$ and $p(t)-t=\theta/s_{Q,P}^D\equiv p^*$. With $MC=0$, per-unit profit is $m=p-z_t=p-t=p^*$. Since $\partial Q/\partial p=f'(p)\,g(A)=-s_{Q,P}^D\,Q$, the price-channel semi-elasticity is $\eta_t^P=-(1/Q)\,(\partial Q/\partial p)\,(dp/dt)=s_{Q,P}^D$. $\square$

Lemma 2 (ad-response). Claim. $\eta_t^A=(\theta/p^*)\,\eta_\tau^A$.

Proof. Let $D\equiv(p-t)\,f\,g''-c''<0$ be the ad second-order condition. Since $\eta_j^A=-(1/Q)\,\frac{\partial Q}{\partial A}\,\frac{dA^*}{dj}$, the ratio $\eta_t^A/\eta_\tau^A=(dA^*/dt)/(dA^*/d\tau)$.

Differentiate FOC (A), $(p-t)\,f\,g'=c'$, in t using $dp/dt=1$:

$$\underbrace{(dp/dt-1)}_{=0}\,fg'+\underbrace{(p-t)\,f'}_{=-\theta f\ \text{[FOC (P)]}}\,\frac{dp}{dt}\,g'+(p-t)\,f\,g''\,\frac{dA}{dt}=c''\,\frac{dA}{dt}$$
$$-\theta\,f\,g'=-D\,\frac{dA}{dt}$$
$$\frac{dA^*}{dt}=\frac{\theta\,f\,g'}{D}$$

Differentiate the ad valorem FOC $(1-\tau)\,p\,f\,g'=c'$ in τ using $dp/d\tau=0$ (Proposition 1); at the common baseline both taxes deliver retention p^*:

$$\begin{aligned}
-p^*\,f\,g'+p^*\,f\,g''\,\frac{dA}{d\tau}&=c''\,\frac{dA}{d\tau}\\
-p^*\,f\,g'&=-D\,\frac{dA}{d\tau}\\
\frac{dA^*}{d\tau}&=\frac{p^*\,f\,g'}{D}
\end{aligned}$$

Therefore

$$\frac{\eta_t^A}{\eta_\tau^A} = \frac{dA^*/dt}{dA^*/d\tau} = \frac{\theta}{p^*}, \qquad \text{i.e.} \qquad \eta_t^A = \frac{\theta}{p^*}\,\eta_\tau^A.$$

□

Remarks. A dollar of mechanical revenue perturbs the ad FOC by θ times as much under the specific tax as under the ad valorem tax: full pass-through leaves the firm's retention $p^* = \theta/s_{Q,P}^D$ unchanged, so quantity falls only because the buyer price rose, whereas under the ad valorem tax the firm's retention itself falls. As $\eta_\tau^A \to 0$ the ad channel vanishes and the specific-tax MEB collapses to the textbook Harberger excise burden with a bias correction.