An Evaluation of Ad valorem and Unit Taxes on Casino Gaming

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Abstract

In several states, casinos pay an ad valorem tax on gross gaming revenue and a tax on each admission to the casino. A formal model of a monopoly casino facing this unique structure of taxation is developed. A comparative statics analysis is then conducted to explore the impact of tax-rate changes on consumer welfare, casino profit, and revenue to state and local governments. The analysis is timely as several states are considering changes to both the tax rates. The results highlight numerous tradeoffs that need to be considered by all relevant parties in the public debate on casino tax policy. The developed model can be applied to any monopoly industry facing ad valorem revenue taxation and per-unit admission taxation.

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1. Introduction

Many consumption goods are subject to either a state-imposed ad valorem tax (e.g., the retail sales tax) or a per-unit tax (e.g., the gasoline tax), but not both.[1] The taxation of casino gaming is somewhat unique because several states subject their casinos to a state-imposed ad valorem tax on gross gaming revenue as well as a per-unit tax.[2] However, unlike other industries that have a per-unit tax levied on the quantity of goods sold, the per-unit tax on casinos is based on the number of patrons that enter the casinos. Thus, the per-unit tax is an admissions tax. The joint ad valorem and per-unit tax structure facing casinos is uncommon across industries; such a structure would be analogous to a retail sales establishment (e.g., Walmart) facing a sales tax on total consumer expenditures as well as facing a tax on each consumer that enters its stores.

The states that levy both an ad valorem and per-unit admissions tax on casino gaming - Illinois, Indiana, Iowa, and Missouri - were some of the first states outside of Nevada and New Jersey that legalized casino gaming in the early 1990s.[3] These early casinos were on riverboats that would make several daily trips along the Mississippi River and other major rivers. Having both an ad valorem tax on casino gaming revenue and a per-unit admissions tax served (and still serves) the different needs of the state and local government (Eadington, 1999). States decided to legalize casino gaming in the early 1990s in the face of increasing pressures on state budgets and the public's growing acceptance of gaming (Calcagno, Walker, and Jackson, 2010). The ad valorem tax on casino revenue provides the state government with what it deems as a new source of revenue to fund important state programs, while at the same time maintaining some control over the growth of the casino industry. The admissions tax essentially taxes the amount of foot-traffic to the casino, which requires the use of local infrastructure such as new parking lots or garages, new streets, added police and fire protection, etc. Revenue from the admissions tax compensates local governments for the infrastructure improvements needed to support new casinos as well as maintaining these improvements after the casinos opened.

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[1] In 2014, seven states partially or fully applied sales taxes to the sale of gasoline in addition to the per-unit gasoline tax (CA, CT, GA, IL, IN, MI, and NY). Source: The Tax Foundation.
[2] Gross gaming revenue is defined as total wagers (handle) minus player winnings.
[3] Iowa also has an admissions tax on casino gaming, but unlike Illinois, Indiana, and Missouri, the state of Iowa gives local governments the option of imposing the admissions tax. Source: Iowa Racing and Gaming Commission.

Although the physical structure of casinos in these states has changed from riverboats to fixed-structures, the structure of the ad valorem tax and the admissions tax has not changed.[4] As is typical of most states with casino gaming, the ad valorem tax on casino gaming revenue generally goes to the state government and is commonly earmarked for education, economic development, and local government transfers. Ad valorem tax rates on gross gaming revenue are graduated in Illinois (15 percent to 50 percent) and Indiana (15 percent to 40 percent), and are fixed in Missouri (21 percent). Revenue from the ad valorem tax on casino gaming in these three states was roughly $1.9 billion (roughly 3 percent of the states' total tax revenue) in 2014.[5] Regarding the admissions tax, revenue from this tax is often split between the city government or county government and the respective state government. The per-unit admissions tax rate is $2 in Missouri, $3 in Indiana, and $2 to $3 in Illinois, and generated revenue totaling $192 million in 2014.

Despite the growth of the casino industry over the past several decades and the uncommon casino-tax structure in some states, there has been almost no theoretical evaluation of casino taxation in the academic literature. Exceptions include Smith (2000), Paton, Siegel, and Williams (2001) and Anderson (2005, 2013). Anderson (2005, 2013) provides an economic analysis of the market for casino gaming under ad valorem taxation and discusses the policy implications of casino taxation. Smith (2000) and Paton, Siegel, and Williams (2001) discuss the relative efficiency of an ad valorem tax on gaming (in general) revenues over a per-unit tax on each bet made. The overall lack of research is surprising given that the taxation of casino gaming, and casino gaming in general, often attracts considerable debate both in the public and in state legislatures across the country.

This paper is the first to develop a formal model of casino gaming under the unique structure of ad valorem revenue taxation and per-unit admissions taxation. Although the developed model is used to analyze the casino industry, the model can be applied to any monopoly. As such, the model presented here is the first to consider an industry facing ad valorem revenue taxation and per-unit admission taxation. A comparative-static analysis is conducted to evaluate the effects of taxation in the casino industry, with a specific focus on how both taxes affect the major parties in the policy debate – consumers, casinos, and state and local governments. Although the economic effects of ad valorem and per-unit taxation under monopoly have been

[4] Tax rates and revenue for each of the three states were obtained from annual reports provided by the Missouri Gaming Commission, the Illinois Gaming Board, and the Indiana Gaming Commission.
[5] Source: U.S. Census' Annual Survey of State Government Tax Collections and states' annual gaming reports.

studied extensively (Suits and Musgrave, 1953) and appear in many microeconomic textbooks, the key difference in the casino industry is that the per-unit tax is levied on each admission to the casino and thus not levied directly on casino output. This fact requires a modification of the traditional model of monopoly under ad valorem and admission taxation in order to capture the real-world taxation environment facing casinos. The comparative statistics yield directional effects that are similar to those obtained from the traditional model of monopoly, but the economic interpretation of the results are different and thus provide unique insights into the effects of ad valorem and admission taxation on consumers, casinos, and state and local governments.

The use of a representative casino rather that the overall market for casino gaming allows a direct assessment, via a comparative static analysis, of how changes in the ad valorem tax rate and the admissions tax rate affect consumer welfare, casino profit, and state and local government casino tax revenue. The results from the comparative static analysis also shed initial light on the efficiency of both forms of casino taxation in general, as well as providing evidence on how partially substituting one tax for another, or abolishing one tax altogether, has impacted casino profit, consumer welfare, and state and local government casino tax revenue. These are both policy-relevant scenarios, as several states have eliminated their admissions tax and other states are considering a change to their casinos' tax rates. The conclusions drawn from the analyses offer both academics and policy-makers new insights that should provide useful for further understanding the economics of casino taxation and the many trade-offs involved in casino tax policy.

The paper proceeds in four additional sections. In Section 2, the profit maximizing model of a monopoly casino is presented and augmented to account for ad valorem taxation of gross gaming revenue and admissions taxation. In Section 3, the model is used as the basis for a comparative static analysis of how changes in the ad valorem tax rate and the admissions tax rate influence the price of casino gaming, casino output, consumer welfare, casino profit, and revenue to state and local governments. Section 4 of the paper provides insight into the tax-rate effects of changing the casino tax mix under the assumption of revenue neutrality; specifically, by how much, on the margin, would one tax rate need to be raised (lowered) if the other tax rate is lowered (raised) in order to keep total casino tax revenue to state and local governments constant. Section 5 of the paper is reserved for concluding remarks and suggestions for future research.

2. A Model of a Monopoly Casino Facing Ad valorem and Admissions Taxes

This section presents the model for a profit-maximizing monopolistic casino that faces both an ad valorem tax on its gross gaming revenue as well as a per-unit tax on its admissions. It is this profit maximization model that serves as the basis for the subsequent comparative static analysis.[6] To begin the analysis, it is first useful to consider profit for a monopoly casino absent any taxation. This general model of monopoly profit is then expanded to account for an ad valorem tax and a per-unit admissions tax.

Profit (π) for the monopoly casino without taxation can be expressed in the simplest form as $\pi = P(Q) \cdot Q - \gamma \cdot Q$, where $P(Q) \cdot Q$ is gross casino gaming revenue and $\gamma \cdot Q$ is total cost. The price (P) of casino gaming is the percentage of each dollar wagered that is not returned to players. The price of casino gaming is often called the "takeout rate" or "win percentage."[7] Fixed costs are assumed to be zero for the casino, and the linear cost function generates average cost equal to marginal cost. Casino output (Q) is traditionally defined as the total amount wagered in the casino, which is commonly referred to as "handle" (see Anderson, 2005, 2013).[8] A unique feature of the casino industry is that a casino's output (Q) depends upon the number of admissions (n) to the casino; specifically, more admissions to the casino yields an increase in the total amount wagered as long as the additional admissions wager any positive amount. Given this relationship between output and admissions, the modified casino profit function absent taxation is expressed as

$$\pi = P(Q(n)) \cdot Q(n) - \gamma \cdot Q(n), \text{ where } \partial Q/\partial n > 0. \quad (1a)$$

Equation (1a) is now modified to account for a single-rate ad valorem tax on gross gaming revenue and a per-unit tax on casino admissions.[9] First consider an ad valorem tax. Under an ad valorem tax (r), there exists a difference between the price paid by gamblers (P) and the price received by the casino,

[6] As with any economic model, the comparative static results are specific to the assumptions and structure of the economic model. The monopoly market structure assumed here provides a starting framework for research in this area. The market structure for casino gaming may more closely resemble monopolistic competition rather than monopoly. However, the profit-maximizing model and profit-maximizing conditions are nearly identical for these two models of market structure; the only difference between the two is that monopolistic competition allows movement in the firm's demand curve due to competitor behavior. A monopolistically competitive market would lend itself to a general equilibrium analysis rather than a partial equilibrium analysis.

[7] The takeout rate is calculated as 1-[prize payouts]/[total wagers]. See Anderson (2005, 2013).

[8] "Handle" includes both the out-of-pocket wagers by casino patrons and any winnings that are wagered again.

[9] Some states impose a progressive tax structure on gross casino gaming revenue rather than imposing a single rate. The assumption of a single rate simplifies the analysis herein without altering the conclusions if a progressive ad valorem tax was considered.

$(P/(1+r))$. For a given level of output, an increase in r creates a larger gap between the price paid by gamblers and the price received by the casinos. Casino output is a function of r since any change in r will influence the casino's optimal choice of Q (based on marginal revenue = marginal cost). Thus, gross casino gaming revenue is $P(Q(n,r)) \cdot Q(n,r)/(1+r)$ and the casino's cost is $\gamma \cdot Q(n,r)$ in the presence of an ad valorem tax.

Now consider a per-unit tax t levied on each admission n. Admissions are an input in the casino's production of total handle Q, so the casino's input demand for admission is $n(t)$. The admissions tax is likely to indirectly influence output via the number of admissions because, in response to an admissions tax, the casino would find it worthwhile at the margin to attract fewer customers (so we have $\partial n/\partial t < 0$) and try to increase wagers per patron (thus influencing optimal casino output). Casino output in the presence of the admission tax and the ad valorem tax can thus be expressed as $Q(n(t),r)$. In addition, the cost-per-patron (and thus the cost per dollar wagered) is positively related to the admissions tax as a result of increased costs related to promotions (e.g., free food and drinks, hotel rooms, event tickets, etc.) and advertising aimed at increasing wagers per patron, so we have $\gamma(t)$ where $\partial\gamma/\partial t > 0$. Finally, the admission tax payments to the state and local government are an additional, non-output related cost facing the casino. The casino's total admission tax payment is $t \cdot n(t)$. Given the above costs facing the casino, total cost for the casino facing a per-unit admissions tax is $\gamma(t) \cdot Q(n(t),r) + t \cdot n(t)$.

With the above modifications to gross gaming revenue and cost under ad valorem and admission taxation, profit for the monopoly casino facing both taxes is

$$\pi = \frac{P(Q(n(t),r)) \cdot Q(n(t),r)}{(1+r)} - \gamma(t) \cdot Q(n(t),r) - t \cdot N(t). \quad (1b)$$

The profit equation (1b) serves as the basis for the comparative static analysis conducted in the next section of the paper.

3. Comparative Static Analyses

To organize the presentation, the comparative static analyses are presented in several sections. The first section examines how changes in the admissions tax rate and the ad valorem tax rate influence the casino's optimal level of output (Q) and the price of casino gaming (P). Given the direction of these changes,

it is then possible to assess the impact that changes in these tax rates have on consumer surplus. The final sections demonstrates how changes in both tax rates influence the optimal level of casino profit as well as casino tax revenue to state and local governments.

3.1 The Impact of Casino Taxation on Output, Price, and Welfare

The casino's objective is to choose the level of Q that maximizes its profit. Differentiating equation (1b) with respect to Q yields the following first-order condition for profit maximization:

$$\frac{\partial \pi}{\partial Q} = \frac{1}{(1+r)} \cdot \left[\frac{\partial P(Q(n(t),r))}{\partial Q(n(t),r)} \cdot Q(n(t),r) + P(Q(n(t),r)) \right] - \gamma(t) = 0 \tag{2a}$$

Equation (2a) provides the optimal value of Q. Assessing how a change in t and a change in r affect the casino's optimal value of Q is done by differentiating equation (2a) with respect to t and with respect to r. First, differentiating equation (2a) with respect to t yields

$$\frac{1}{(1+r)} \cdot \left[\frac{\partial^2 P}{\partial Q^2} \cdot \frac{\partial Q}{\partial n} \cdot \frac{\partial n}{\partial t} \cdot Q + 2 \cdot \frac{\partial P}{\partial Q} \cdot \frac{\partial Q}{\partial n} \cdot \frac{\partial n}{\partial t} \right] - \frac{\partial \gamma}{\partial t} = 0,$$

$$\equiv \frac{\partial Q}{\partial n} \cdot \frac{\partial n}{\partial t} \cdot \frac{1}{(1+r)} \cdot \left[\frac{\partial^2 P}{\partial Q^2} \cdot Q + 2 \cdot \frac{\partial P}{\partial Q} \right] = \frac{\partial \gamma}{\partial t},$$

and, recognizing that the chain rule yields $\frac{\partial Q}{\partial t} = \frac{\partial Q}{\partial n} \cdot \frac{\partial n}{\partial t}$, we obtain the desired result

$$\frac{\partial Q}{\partial t} = \frac{\frac{\partial \gamma}{\partial t} \cdot (1+r)}{\left(\frac{\partial^2 P}{\partial Q^2} \cdot Q + 2 \cdot \frac{\partial P}{\partial Q} \right)} < 0, \quad \blacksquare \tag{2b}$$

where the negative sign is obtained by recognizing that the numerator is positive and the denominator, which is the second derivative of the profit function with respect to output (or the first derivative of marginal revenue), is negative for profit maximization.[10] Since the change in optimal output is negatively related to a change in the admissions tax, it follows that a change in this tax should be positively related to the optimal price of casino gaming. This is easy to demonstrate using the chain rule $\frac{\partial P}{\partial t} = \frac{\partial P}{\partial Q} \cdot \frac{\partial Q}{\partial t}$. Since $\frac{\partial Q}{\partial t} < 0$ from equation (2b), the expected result is

[10] Marginal revenue need not be downward sloping, depending upon the specific demand function. But, in the case of constant marginal costs assumed here, a downward sloping marginal revenue curve is required for profit maximization.

$\frac{\partial P}{\partial t} > 0.$ ■ (2c)

The signs of the above comparative statics are the same as those obtained from the traditional model of monopoly under per-unit taxation. However, recall why the economic mechanics are different for the monopoly casino — in response to a per-unit tax on admissions the casino may find it worthwhile to decrease the number of admissions and increase total wagers from the smaller number of patrons. So, the degree to which output decreases in response to the admissions tax (and thus the degree of distortion due to the tax) depends upon the casino's adjustment of admissions. Indeed, in the extreme, if the casino treats the number of admissions as exogenous and thus makes no change in response to the admissions tax, then the casino's marginal and average costs will remain unchanged and the admission tax payment becomes a fixed cost (with respect to output) for the casino.[11] As a result, a change in the admissions tax will not be distortionary as there would be no resulting change in the optimal output or the optimal price.

Now consider the effect of a change in the ad valorem tax on casino output and price. Differentiating equation (2a) with respect to r yields

$$\frac{\partial Q}{\partial r} \cdot \left[\frac{\partial^2 P}{\partial Q^2} \cdot Q + 2 \cdot \frac{\partial P}{\partial Q}\right] \cdot (1 + r) - \frac{\partial P}{\partial Q} \cdot Q - P = 0,$$

and solving for $\partial Q / \partial r$ yields the result

$$\frac{\partial Q}{\partial r} = \frac{\frac{\partial P}{\partial Q} \cdot Q + P}{\left(\frac{\partial^2 P}{\partial Q^2} \cdot Q + 2 \cdot \frac{\partial P}{\partial Q}\right)(1 + r)} < 0, \quad \blacksquare \tag{2d}$$

where the negative relationship is determined by recognizing that the numerator divided by $(1 + r)$ is marginal gaming revenue to the casino (which is > 0), and that the first term in parentheses in the denominator is negative under profit maximization. This term is also equal to the slope of the marginal revenue curve, which allows the conclusion that changes in the ad valorem tax rate will have a smaller effect on casino output the steeper the slope of the marginal revenue curve. This in turn implies that a change in the ad valorem tax rate will have a smaller effect on casino output (and will thus be less distortionary) the less

[11] In the case of exogenous admissions, we have $Q(t, r)$ and total cost of $\gamma \cdot Q(t, r) + t \cdot n$. Maximizing profit with respect to output and then differentiating with respect to t yields $\partial Q / \partial t = 0$ and, via the chain rule, $\partial P / \partial t = 0$.

elastic the demand for casino gaming.[12] Note that this is true for the admissions tax as well since the denominator term in equation (2b) is the same as in equation (2d).

The negative relationship between casino output and the ad valorem tax rate implies a positive relationship between the price of casino gaming and the ad valorem tax. This is straightforward to verify using the chain rule $\frac{\partial P}{\partial r} = \frac{\partial P}{\partial Q} \cdot \frac{\partial Q}{\partial r}$. Since $\frac{\partial Q}{\partial r} < 0$ from equation (2d), the expected result is

$$\frac{\partial P}{\partial r} > 0, \quad \blacksquare \tag{2e}$$

Along with equation (2d), the positive derivative of equation (2e) reveals that a change in the ad valorem tax rate will have a larger effect on the price of casino gaming the steeper is the slope of the marginal revenue curve, which implies that an ad valorem tax rate change will have a larger effect on the price of casino gaming the less elastic the demand for casino gaming.

3.2 The Impact of Taxation on Casino Profits

This section explores the impact of changes in the ad valorem tax rate and the admissions tax rate on optimal casino profit. The profit-maximizing values of Q and P are used in equation (1b) to arrive at the expression for optimal casino profits:

$$\pi^* = \frac{P^*(Q^*(n(t),r)) \cdot Q^*(n(t),r)}{(1+r)} - \gamma(t) \cdot Q^*(n(t),r) - t \cdot N(t), \tag{2f}$$

where '*' denotes the optimal value. The effect of tax changes on optimal casino profit can be determined by differentiating equation (2f) with respect to t and r, as shown below (ignoring '*' hereafter).

First, consider the admissions tax. Differentiating equation (2f) with respect to t and rearranging terms yields

$$\frac{\partial \pi}{\partial t} = \frac{1}{(1+r)} \cdot \frac{\partial Q}{\partial n}\frac{\partial n}{\partial t} \cdot \left[\frac{\partial P}{\partial Q} \cdot Q + P - \gamma(1+r)\right] - \left[\frac{\partial \gamma}{\partial t} \cdot Q + n + \frac{\partial n}{\partial t} \cdot t\right],$$

[12] This is straightforward to show. Assuming a linear inverse demand curve for casino gaming for simplicity, then equation (2d) becomes $[Q + P \cdot \partial Q/\partial P]/[2(1+r)]$. Multiplying the numerator and denominator by $1/Q$ and rearranging terms yields the final equation $[(1+\varepsilon) \cdot Q]/[2(1+r)]$, where ε is the price elasticity of demand for casino gaming. Since a monopolist only produces where $\varepsilon < -1$, then $\partial Q/\partial r$ is smaller in magnitude (less negative) the less elastic the demand for casino gaming. Thalheimer and Ali (2003) and Landers (2008) empirically estimate the price elasticity of demand for casino gaming and find an average price elasticity of demand of around -1.3. See Suits (1979) for a formal description of the relationship between gaming tax rates and revenue to governments.

and, recognizing that the term in the first set of brackets is simply marginal revenue minus marginal cost (which is zero under profit maximization), the final result is

$$\frac{\partial \pi}{\partial t} = -\left[\frac{\partial \gamma}{\partial t} \cdot Q + n + \frac{\partial n}{\partial t} \cdot t\right] < 0, \quad \blacksquare \tag{2g}$$

where $(\partial \gamma / \partial t) \cdot Q$ is the change in average/marginal cost and the expression $n + (\partial n / \partial t) \cdot t$ reflects the change in admissions tax collections (revenue). Certainly the expectation is that a higher (lower) admission tax will reduce (increase) profit, but the negative sign of equation (2g) may not be obvious since $\partial \gamma / \partial t > 0$ and $\partial n / \partial t < 0$. The intuition for the negative sign can be had by multiplying both sides of equation (2g) by -1 and dividing both sides by n, which yields

$$\left(\frac{\frac{\partial \gamma}{\partial t} \cdot Q}{n}\right) + (1 + \varepsilon_{n,t}) > 0,$$

where $\varepsilon_{n,t}$ is the casino's elasticity of demand for admissions, which is negative given $\partial n / \partial t < 0$. For the positive condition to hold, it must be the case that the change in average/marginal cost per patron (the first term in parentheses) is greater than the change in admission tax revenue per patron (the second term in parentheses). The first term is clearly positive, but the sign of the second term depends upon the size of $\varepsilon_{n,t}$. Low values of t will most likely correspond to the inelastic portion of the input demand curve since t is unbounded from above, so the inelastic input demand implies that an increase in the tax rate will increase admission tax revenue. Thus, we have $1 + \varepsilon_{n,t} > 0$ and $|\varepsilon_{n,t}| < 1$, which is a standard result in public finance that the government should levy a per-unit tax on an inelastic good if the objective is to increase tax revenue. The above discussion thus confirms the negative relationship between admission and casino profit derived in equation (2g).[13]

Now consider the change in optimal casino profit resulting from a change in the ad valorem tax rate on gaming revenue. Differentiating equation (2f) with respect to r and rearranging terms yields

$$\frac{\partial \pi}{\partial r} = \frac{\frac{\partial Q}{\partial r} \cdot \left[\frac{\partial P}{\partial Q} \cdot Q + P - \gamma(t) \cdot (1 + r)\right]}{(1 + r)} - \frac{P \cdot Q}{(1 + r)^2},$$

[13] In the case of exogenous admissions (see note 11), $\partial \pi / \partial t = -n$.

where the bracketed term is equal to zero (marginal revenue minus marginal costs under ad valorem taxation). The final result is thus

$$\frac{\partial \pi}{\partial r} = -\frac{P \cdot Q}{(1+r)^2} < 0, \quad \blacksquare \tag{2h}$$

which is interpreted as the reduction (increase) in profits resulting from a greater (smaller) percentage of casino gaming revenue going to the state from a given change in r.

3.3 The Impact of Taxation on Revenue to State and Local Governments

This section examines the effect of changes in the ad valorem tax rate and the admissions tax rate on government revenue. The revenue generated from the taxing of casino gaming is likely to be the predominant concern of policy-makers since revenue from both taxes are earmarked for specific programs or activities. In general, states that levy both taxes on casinos dedicate the ad valorem tax revenue to the state government and the admissions tax revenue to the casino's local government.[14]

First consider changes to admissions tax revenue (R_t) resulting from changes in both t and r. Admissions tax revenue is $R_t = t \cdot n(t)$. So we have

$$\frac{\partial R_t}{\partial t} = n + \frac{\partial n}{\partial t} \cdot t > 0, \quad \blacksquare \tag{2i}$$

where the positive sign is based on earlier discussion. We also have

$$\frac{\partial R_t}{\partial r} = 0. \quad \blacksquare \tag{2j}$$

Now consider changes to ad valorem tax revenue (R_r) resulting from a change in t. Revenue from the ad valorem tax on gross casino revenue is

$$R_r = \frac{r \cdot P(Q(n(t), r)) \cdot Q(n(t), r)}{(1+r)}. \tag{2k}$$

Differentiating equation (2k) with respect to t and collecting terms gives

$$\frac{\partial R_r}{\partial t} = \left(\frac{r}{1+r}\right) \cdot \frac{\partial Q}{\partial n} \cdot \frac{\partial n}{\partial t} \cdot \left[\frac{\partial P}{\partial Q} \cdot Q + P\right],$$

or, since it has been established that $\frac{\partial Q}{\partial t} = \frac{\partial Q}{\partial n} \cdot \frac{\partial n}{\partial t} < 0$, the final result is

[14] It is not uncommon, however, for there to be some revenue sharing from each tax, especially if there only exists an ad valorem tax on gross gaming revenue.

$$\frac{\partial R_r}{\partial t} = \left(\frac{r}{1+r}\right) \cdot \frac{\partial Q}{\partial t} \cdot \left[\frac{\partial P}{\partial Q} \cdot Q + P\right] \quad < 0. \ \blacksquare \tag{2l}$$

The intuition of equation (2l) is as follows: an increase in the admission tax rate will result in less casino output (wagers) via a reduction in the number of admissions resulting from the higher tax (i.e., a higher admission tax will increases the price of the casino's input); so, fewer total wagers in the presence of a constant ad valorem tax rate will therefore reduce ad valorem tax revenue.

The comparative statics results in equation (2i) and equation (2l) reveal that there thus exists a tradeoff between ad valorem tax revenue and admission tax revenue when the admissions tax rate is changed. The state government's attempt to increase revenue through the admissions tax will be offset by (some) reduction in ad valorem tax revenue. How large the tradeoff in revenue would be depends upon the magnitudes of the elasticity of demand for admissions (equation 2i) and the elasticity of demand for casino gaming (equation 2l). Furthermore, the tradeoff in revenues reveals potential conflicts between the state government and the local government, as the former generally receives the bulk of ad valorem tax revenue and the latter receives the bulk of admission tax revenue.

Now consider changes to ad valorem tax revenue (R_r) resulting from a change in the ad valorem tax rate. Differentiating equation (2k) with respect to r yields

$$\frac{\partial R_r}{\partial r} = \frac{P \cdot Q}{(1+r)^2} + \left(\frac{r}{1+r}\right) \cdot \frac{\partial Q}{\partial r} \cdot \left[\frac{\partial P}{\partial Q} \cdot Q + P\right], \tag{2m}$$

and by recognizing that the term in brackets is marginal revenue (MR), equation (2m) can be simplified to get the desired result

$$\frac{\partial R_r}{\partial r} = \frac{P \cdot Q}{(1+r)^2} + \left(\frac{r}{1+r}\right) \cdot \frac{\partial GR}{\partial r} > 0, \quad \blacksquare \tag{2n}$$

where GR denotes gross casino gaming revenue and $\frac{\partial GR}{\partial r} \equiv \frac{\partial GR}{\partial Q} \cdot \frac{\partial Q}{\partial r} \equiv MR \cdot \frac{\partial Q}{\partial r}$.

The intuition behind the result in equation (2n) is worth noting. The second term is the reduction in gross casino gaming revenue resulting from a change in output due to a change in the ad valorem tax rate. Since it has been established earlier in the analysis that $\frac{\partial Q}{\partial r} < 0$, the entire second term of the partial

derivative in equation (2n) is negative.[15] The first term on the right-hand side is the change in ad valorem tax revenue to the state resulting from a change in the percent of gaming revenue going to the state. This term is clearly positive. What the two terms in equation (2n) demonstrate is that the sum of the two effects will be positive as long as an increase in r does not result in a large enough reduction in output (Q) to actually cause casino gaming revenue (the tax base) to decrease in size. For "low" ad valorem tax rates, it seems reasonable that gross gaming revenue will not fall in response to an increase in the tax rate, so that ad valorem tax revenue to the state rises in response to an increase in the ad valorem tax rate, i.e. $\frac{\partial R_r}{\partial r} > 0$.

It is worth concluding this section with a brief summary of the comparative static results. As in the traditional model of monopoly, casino output is negatively related to changes in both the admission tax rate and the ad valorem tax rate; the price of casino gaming is positively related to a change in each of the tax rates. Thus both taxes are distortionary and reduce consumer surplus. The degree of distortion depends upon the elasticity of demand for casino gaming. However, unlike the traditional model of monopoly, the degree of distortion from the admissions tax also depends upon the elasticity of the casino's demand for admissions (since, as is unique to casino gaming, changes in admissions affects the casino's output). Changes in both tax rates have a negative effect on casino profit and, for the admission tax, the magnitude of the change in profit also depends on the elasticity of the casino's demand for admissions. Finally, increasing both tax rates will increase state and local government tax revenue from the respective revenue source, but state and local governments face an interesting tradeoff in total tax revenue when making changes to the admission tax; namely, an increase (decrease) in the admission tax will decrease (increase) ad valorem tax revenue holding the ad valorem tax rate constant.

4. Changing the Mix of Tax Rates

The following analysis considers the scenario where a state government is considering making a marginal change to either the admissions tax rate or the ad valorem tax rate, where any change will be revenue neutral with respect to total casino tax revenue (revenue from the ad valorem tax plus revenue from the admissions tax). This is a policy-relevant issue, as some states have eliminated one form of casino

[15] Combs, Landers, and Spry (2013) find that the elasticity of gross gaming revenue in Illinois casinos with respect to a change in the advalorem rate is approximately -0.23.

taxation (e.g., Louisiana eliminated the admissions tax) and others states are currently considering changing their tax mix (e.g., Indiana is currently debating whether or not to lower or eliminate their admissions tax). Changing the casino tax mix has important implications, as evidenced by the differential impacts of each tax on consumer surplus, price, casino output, and casino profit found in the earlier comparative static analysis.

Total casino tax revenue (TR) is the sum of revenue from the ad valorem tax (R_r) and revenue from the admissions tax (R_t), or

$$TR = R_r + R_t. \tag{3a}$$

Totally differentiating the above expression with respect to t and r and setting $dTR = 0$ (revenue neutrality) gives

$$0 = \left[\frac{\partial R_r}{\partial r} + \frac{\partial R_t}{\partial r}\right] \cdot dr + \left[\frac{\partial R_r}{\partial t} + \frac{\partial R_t}{\partial t}\right] \cdot dt,$$

where the specific expressions for the partial derivatives have been derived in the previous section. Using equation (3a), the above expression can be simplified to

$$0 = \left[\frac{\partial TR}{\partial r}\right] \cdot dr + \left[\frac{\partial TR}{\partial t}\right] \cdot dt,$$

and rearranged to obtain the desired result

$$dr = -\frac{\frac{\partial TR}{\partial t}}{\frac{\partial TR}{\partial r}} \cdot dt. \quad \blacksquare \tag{3b}$$

Equation (3b) is interpreted as follows: For a given change in the admission tax rate (dt), the change in the ad valorem tax rate (dr) should be equal to the negative of the ratio of the changes in total tax revenue resulting from changes in each tax in order to keep total tax revenue constant.[16] A similar result can be obtained for a change in the ad valorem tax rate by rearranging equation (3b) and solving for dt,

$$dt = -\frac{\frac{\partial TR}{\partial r}}{\frac{\partial TR}{\partial t}} \cdot dr. \quad \blacksquare \tag{3c}$$

[16] The preceding analysis can also be used to examine the effect that completely eliminating one tax has on the remaining tax's rate. In this scenario, dt in equation (3b) and dr in equation (3c) would be equal to the negative of the value of the current tax rate.

Several points are worth mentioning. First, the above analysis assumes that total casino tax revenue remains unchanged. However, any change to the tax mix will not yield a revenue-neutral outcome for both the state government and the local government. For example, if a state decreases the admissions tax rate and increases the ad valorem tax rate, revenue to local government (which receives the bulk of admission tax revenue) will be less and revenue to the state government will be higher. The local government is likely to find this outcome undesirable and perhaps appeal to the state government for a portion of the ad valorem tax revenue. Similarly, revenue sharing from the local government to the state government may be necessary if the admissions tax rate is increased and the ad valorem rate is decreased. The main point is that some revenue-sharing between the two levels of government may be required (or altered if it already exists) given that one level of government would experience less tax revenue after the change to the tax rates.

Second, changing tax rates will also affect consumer welfare. The degree to which welfare is affected depends upon the specific tax rate adjustment (i.e., raising the admission tax and lowering the ad valorem tax, or raising the ad valorem tax and lowering the admission tax) and the resulting relative changes to price and output under the new tax rate regime.

Third, the comparative static analysis in the previous section suggests that changing the tax mix has implications for casino profit since changes in each tax rate have been found to have different effects on casino profit. Casinos are most certainly aware of the differential impacts each tax has on their profit. In fact, the state of Indiana is considering legislation, supported by the state gaming industry, that would abolish the $3 admission tax and increase the ad valorem tax by three percentage points.[17] Given that casinos in Indiana support this legislation, it must be the case that casino profits will be higher if the admission tax is abolished and the ad valorem tax is increased. This can be shown as follows:

The total change in casino profit with respect to changes in each tax rate is

$$d\pi = \frac{\partial \pi}{\partial t} dt + \frac{\partial \pi}{\partial r} dr.$$

For $d\pi > 0$, the above expression can be rearranged to get the result

$$\frac{\partial \pi}{\partial t} dt > -\frac{\partial \pi}{\partial r} dr. \blacksquare$$

[17] See https://www.casino.org/news/indiana-casinos-3-admission-tax-might-be-headed-for-exit-soon (last access October 2017).

It thus must be the case that the increase in profits from abolishing the admission tax is greater than the reduction in profits from an increase in the ad valorem tax rate. A more specific interpretation can be had by recalling the previous expressions for each of the two partial derivatives (equations (2g) and (2h)) that were derived in the previous section: the decrease in admission tax payments and marginal costs (which both increase profit) must be greater than the revenue loss (which decreases profit) from an increase in the ad valorem tax rate. Or, in other words, the cost decrease from abolishing the admission tax is greater than the revenue decrease from increasing the ad valorem tax rate.

5. Discussion and Concluding Comments

The casino gaming industry is subject to state-imposed ad valorem taxes on gross gaming revenue as well as per-unit taxes, where the per-unit tax is a tax on casino admissions rather than a tax on casino output. This unique tax structure facing the casino industry has received very little attention in the academic literature. This paper served as a starting point for research on this structure of taxation by developing the first formal model of a profit-maximizing casino facing both types of taxes. Although the model is used to analyze the casino industry, the model is really the first to consider an industry facing ad valorem revenue taxation and per-unit admission taxation and, as a result, is general enough that it can be applied to any monopoly industry. A comparative-static analysis evaluated the effects of ad valorem and per-unit taxation on several policy-relevant variables, such as the price of casino gaming, casino output, casino profit, welfare, and tax revenue to state and local governments. These variables are relevant to all parties in the public debate on the taxation of casino gaming.

The comparative static analysis demonstrated that changes in the rate for each type of tax will have quite different impacts on casino profit, consumers, and revenue to state and local governments. Many of the comparative static directional effects are similar to those obtained from the traditional model of monopoly under ad valorem and per-unit (output) taxation. However, the interpretation of the results, especially with respect to the admissions tax, is different and relates to the elasticity of the casino's demand for admissions. The comparative static analysis also provides insight into the mix of taxes and tax rates that would be preferred by the casino industry, consumers, and state and local governments, each of whom has different objectives. Another important finding is that any policy to change one tax rate may harm or benefit

consumers or the casino, depending upon the final mix of tax rates that is chosen. This is true regardless of whether or not the government pursues a revenue-neutral casino tax policy. Given that several states have abolished their admissions tax and have increase their ad valorem tax on gaming revenue, and several others are considering doing so, the results highlight the conflicting objectives of consumers, casinos, and state and local governments. These conflicting objectives demonstrate the many trade-offs to be made in casino tax policy.

The partial equilibrium analysis of the monopoly casino presented here provides a framework for future research. The comparative static results are specific to the assumptions and structure of the economic model, so the consideration of additional complexities and realities should prove to be a fruitful extension of the analysis presented here. One avenue for future research is to study casino taxation within a general equilibrium framework that considers the competitive effects from other casinos as well as other sectors of the local economy. Casinos within the same state are subject to the same tax rates, so the general equilibrium framework may also consider competition with bordering states and regions. This competition would essentially increase and decrease the demand curve for the representative casino, yielding a new profit maximizing level of output and price, and thus tax revenue, consumer surplus, and casino profit. Similarly, casinos not only compete with each other, but also with other businesses in the area that generate tax revenue (from sales taxes, income taxes, hotel occupancy taxes, etc.) for state and local governments. This potential substitution has been studied empirically (Anders, Siegel, and Yacoub, 1998; Walker and Jackson, 2011; Humphreys and Marchand, 2013; Nichols, Tosun, and Yang, 2015), but a general equilibrium framework may provide additional insights into how changing casino tax rates within this competitive framework would affect local businesses, employment, and total tax revenue to governments (Geisler and Nichols, 2016).

While the analysis here provides insights into the efficiency of ad valorem taxes on gross gaming revenue and the tax on casino admissions, determining the adequacy of both taxes is important as well. How well does each revenue source allow state and local governments to meet their budget goals? How does the growth and variability of each tax base (casino admissions and gaming revenue) perform relative to economic conditions? Nichols and Tosun (2008) provide some indirect evidence on the adequacy of ad valorem taxes on gross gaming revenue by estimating long-run and short-run income elasticities for gross

casino gaming revenue. To date no work has examined the adequacy of the admission tax. An understanding of the adequacy of both forms of taxes would provide information on the proper mix of casino taxes needed to meet adequacy goals; of course, realizing that a casino tax policy to meet adequacy goals (by raising, lowering, or abolishing a tax) would likely have implications for efficiency and casino profit.

Disclosure Statement

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References

Anders, Gary; Donald Siegel, and Munther Yacoub. "Does Indian Casino Gambling Reduce State Revenues? Evidence from Arizona." *Contemporary Economic Policy*, vol. 16, no. 3 (July 1998), 347-355.

Anderson, John E. "Casino Taxation in the United States." *National Tax Journal*, vol. 58, no. 2 (June 2005), 303-324.

Anderson, John E. "The Economics of Casino Taxation." In *The Oxford Handbook of The Economics of Gambling,* eds. Leighton Vaughan Williams and Donald S. Siegel, Oxford University Press, 2013, 18-36.

Calcagno, Peter T., Douglas M. Walker, and John D. Jackson. "Determinants of the Probability and Timing of Commercial Casino Legalization in the United States." *Public Choice,* vol. 142 (January 2010), 69-90.

Combs, Kathryn L; Jim Landers, and John Spry. "The Responsiveness of Casino Revenue to the Casino Tax Rate." Working paper, Department of Finance University of St. Thomas, 2013.

Eadington, William. "The Economics of Casino Gambling." *Journal of Economic Perspectives*, vol. 14, no.3 (Summer 1999), 173-192.

Geisler, Karl R. and Mark W. Nichols. "Riverboat Casino Gambling Impacts on Employment and Income in Host and Surrounding Counties." *Annals of Regional Science*, vol. 56, no. 1 (January 2016), 101-123.

Humphreys, Brad R. and Joseph Marchand., "New casinos and local labor markets: Evidence from Canada." *Labour Economics*, vol. 24(C), (2013), 151-160.

Landers, Jim. "What's the Potential Impact of Casino Tax Increases on Wagering Handle: Estimates of the Price Elasticity of Demand for Casino Gaming." *Economics Bulletin*, vol. 8, no. 6 (2008), 1-15

Nichols, Mark and Mehmet Serkan Tosun. "The Income Elasticity of Demand for Gross Casino Revenues: Short-run and Long-run Estimates." *National Tax Journal*, vol. 61, no. 4 (December 2008), 635-652.

Nichols, Mark; Mehmet Serkan Tosun, and Jingjing Yang. "The Fiscal Impact of Legalized Casino Gambling." *Public Finance Review*, vol. 43, no. 6 (November 2015), 739-761.

Paton, David; Donald S. Siegel, and Leighton Vaughan Williams. "Gambling Taxation: A Comment." *The Australian Economic Review*, vol. 34, no. 4 (December 2001), 437-440.

Smith, Julie P. "Gambling Taxation: Public Equity in the Gambling Business." *Australian Economic Review*, vol. 33, no. 2 (June 2000), 120-144.

Suits, Daniel B. "The Elasticity of Demand for Gambling." *The Quarterly Journal of Economics*, vol. 93, no. 1 (February 1979), 155-162.

Suits, Daniel B. and Richard A. Musgrave. "Ad Valorem and Unit Taxes Compared." *The Quarterly Journal of Economics*, vol. 67, no. 4 (November 1953), 598-604.

Thalheimer, Richard and Mukhtar M. Ali. "The Demand for Casino Gaming." *Applied Economics*, vol. 35, no. 8 (2003), 907-918.

Walker, Douglas and John D. Jackson. "The Effect of Legalized Gambling on State Government Revenue." *Contemporary Economic Policy*, vol. 29, no. 1 (January 2011), 101-114.