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The Income Elasticity of Casino Revenues: Short-Run and Long-Run Estimates

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Abstract

In this paper we examine how casino gambling revenues differ from other major tax revenues in growth and variability. We estimate the long-run and short-run income elasticities using state-level casino revenue and state, regional and national income. Our empirical analysis includes eleven states that have significant casino gambling. To estimate income elasticities, we run separate time-series regressions for each of these states, controlling for supply-side industry effects. Our findings show that Nevada's casino revenue base growth is more sensitive to national than state income, while such growth is more tied to state and regional income in riverboat states. Casino revenue base growth is generally faster than taxable sales, but slower than taxable income. Short-run (immediate) elasticity is, on average, lower than estimates for sales and income taxes, with an equal or more rapid adjustment to long-run equilibrium. These estimates also reveal greater variability when regional or national income changes are taken into consideration. This suggests that states that depend heavily on out-of-state visitors in their gambling operations may be more susceptible to changes in regional or national economic activity.

JEL Classification: H71, L83

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1. Introduction

Commercial casino gambling is a major industry that has experienced substantial growth in recent decades. Garrett and Nichols (forthcoming) note that the casino gambling industry had reached $44 billion in adjusted gross revenue in 2003, which accounted for about 60% of all gambling revenues in the U.S.[1] Landers (2007) shows that casino gambling tax collections constitute a significant portion of total state tax collections in many states, with the highest share (16.3%) in Nevada as of FY2006.[2] State fiscal crises have also led many states to turn to gambling as a quick solution to state fiscal problems in recent times.[3] Given this, it is important to show what those states might expect from commercial gambling in the future. A relevant question, then, is how gambling tax revenues differ from other traditional major state taxes, such as sales and income tax, in growth and variability.

While past studies on income elasticity of state taxes used calculated tax bases or national proxies, the literature also discussed the problems with this approach and advised using actual tax bases (e.g., Holcombe and Sobel, 1997). In addition, most studies used annual instead of quarterly data, missing the more accurate picture of changes in economic activity during a given year. We also see a gap in the literature as we haven't come across any recent studies on the income elasticity of gambling revenues despite major changes in the gambling industry, particularly in the last two decades. We are addressing these weaknesses in the literature by estimating the long-run and short-run

[1] This comes from commercial casinos in 11 states and Native American casinos in 23 states.
[2] Landers (2007) shows that the average share of gambling taxes in states with riverboat gambling (Illinois, Indiana, Iowa, Louisiana and Missouri) was close to 5% in FY2006.
[3] Tosun and Skidmore (2004) show evidence of intense competition between states in gambling through state lotteries. Their study points to the importance of cross-border sales in the return from gambling activities in the state.

income elasticities of the actual tax base of gambling revenues using state-level quarterly data on gross gambling revenue and state, regional and national income. Our empirical analysis includes eleven states that have significant casino gambling. We group these states as follows: Nevada, New Jersey, Mississippi (Destination Resorts)[4]; Illinois, Indiana, Iowa, Louisiana, Missouri (Riverboat Casinos); Colorado, South Dakota (Mining Towns); and Connecticut (Indian Casinos). To estimate income elasticities, we run separate time-series regressions for each of these states, controlling for supply-side industry effects. Our findings show that Nevada's casino revenue base growth is more sensitive to national than state income, while such growth is more tied to state and regional income than national income in riverboat states. Casino revenue base growth is generally faster than taxable sales, but slower than taxable income. Short-run (immediate) elasticity is, on average, lower than estimates for sales and income taxes, with an equal or more rapid adjustment to long-run equilibrium.

The paper is structured as follows. In the next section we review the literature on the income elasticity of state taxes, including a small literature on gambling revenues. We provide a detailed description of our empirical model and data in Section 3. In Section 4 we present our empirical results from a regression analysis. We summarize our results and provide a discussion with our concluding remarks in the final section.

2. Previous Studies

Earlier studies on the income elasticity of state taxes gave only long-run estimates of income elasticities. The seminal paper by Groves and Kahn (1952) used double-log OLS specification to estimate long-run income elasticity of various state taxes using

[4] The term "destination resort casinos" was coined by Eadington (1998).

annual tax revenue data. Cargill and Eadington (1978) and Babbel and Staking (1983) followed suit. In fact, to the best of our knowledge, these two are the only studies that examined income elasticity of gambling, and Cargill and Eadington (1978) is the only one that has examined casino gambling specifically.[5] Cargill and Eadington used seasonally adjusted data for the period 1960-1974 and found that the income elasticity of gross gambling revenue is fairly elastic with significant variation across three regions in Nevada. The highest is in the Las Vegas region (1.75), followed by the Lake Tahoe (1.25) and the Reno-Sparks (1.05) regions. Cargill and Eadington used California personal income in the regressions for income elasticity to capture the responsiveness of gambling revenue to regional income changes. This is important since the casino gambling industry in most states is driven by visitors to the state from the neighboring region.

In the next phase of the literature, studies distinguished between growth and variability of tax bases by separately estimating long-run and short-run elasticities.[6] In one of the earlier studies, Fox and Campbell (1984) used a varying elasticity model to estimate various short-run elasticities for 10 different categories of sales tax bases in Tennessee. Also differently, they use quarterly data on the sales tax base, calculated from sales tax revenue data. They note the advantages of using quarterly data as having more degrees of freedom and allowing a closer link between economic activity and consumption. They found that sales tax is an unstable revenue source as the short-run

[5] Suits (1979) examined gambling tax revenues by looking at the price elasticity of demand for gambling. Landers (2007) examined demand elasticity for gambling with respect to changes in the win percentage. Babbel and Staking (1983) estimated the Engel Curve for lottery expenditures and life insurance in Brazil using the double-log OLS specification and found that lotteries have close to unitary income elasticity.
[6] See Dye (2004) for an excellent review of the literature on short-run income elasticity of state taxes.

elasticities move in a procyclical fashion.[7] Dye and McGuire (1991) extended this analysis by showing evidence of both growth and variability in state income and sales taxes. They did this by estimating the trend rate of growth and the deviation from trend for different components of these tax bases.[8] They found that taxes with high long-run elasticity (e.g. income tax) can be more stable than a tax with lower long-run elasticity (e.g. sales tax). Hence, the trade-off between growth and variability in state taxes may not hold. They used national data to approximate tax bases for states. While this brought significant simplicity in the analysis of income elasticities for different states, it also led to a potential error in the use of appropriate tax bases.

Sobel and Holcombe (1996) also distinguished between long-run and short-run income elasticities, but their econometric approach is different from the previous studies. While they used a Dynamic OLS (DOLS) specification for the long-run elasticity estimation, they used an Error Correction Model to estimate short-run elasticities. They argue that the Error Correction Model gives superior results compared to Dye and McGuire's deviation from trend approach in the presence of non-stationarity in tax revenues. Similar to Dye and McGuire (1991), Sobel and Holcombe (1996) used proxies for bases of various taxes. In a related and expanded study, Holcombe and Sobel (1997) addressed cyclical variability in state individual income and state retail sales taxes using federal adjusted gross income in the state and total state retail sales, respectively, as tax bases.[9] They, too, did not find evidence of a trade-off between variability and growth in

[7] Otsuka and Braun (1999) revisited Fox and Cambell (1984) using an alternative random coefficient model and mainly confirmed their conclusions.
[8] This approach was first used by White (1983)
[9] This allowed them to estimate income elasticities even for states that don't have personal income tax or retail sales tax. We use their estimates for Nevada, Indiana, South Dakota and Connecticut in our elasticity comparisons in Table 2.

state tax bases, except in the case of food exemption from the retail sales tax base. A recent study by Bruce, Fox and Tuttle (2006) improved on the previous studies by using state-level data for tax bases instead of national proxies. Their data procedure still falls short of using data on actual tax bases since they calculate tax bases from state tax revenue data. They also contribute by showing the asymmetry in short-run elasticities. Short-run elasticity estimates could be significantly different depending on whether current revenue is above or below the long-run equilibrium.

We build on the literature discussed above but make several improvements and contributions. First, we use quarterly data as in Fox and Campbell (1984), but expand the analysis to a number of states instead of just one. Second, we use data on the actual tax base for the first time in the literature, thus removing the potential error inherent in previous studies that used proxies. Third, we are adding a new estimate of the income elasticity of casino gambling revenues to the list of past elasticity estimates that included state taxes like the individual income tax, general sales tax, corporate income tax, motor fuel tax, tobacco tax and alcohol tax. Finally, we also examine the responsiveness of the gambling tax base to changes in regional income in the vicinity of the state and changes in national income. This is important since casino gambling revenues might be quite sensitive to visitors from the state's region or even from the entire nation, as in the case of Nevada.

3. Empirical Model and Data

This study uses econometric methodologies developed by Sobel and Holcombe (1996) and Bruce, Fox, and Tuttle (2006) to estimate the short-run and long-run income

elasticities of casino gambling revenue. Unlike these and the studies reviewed above, however, the current study examines a very specific tax base, casino gambling revenue, rather than a broad base such as taxable sales or income. This requires that some specific, supply-side characteristics of the industry be accounted for.

Long-Run Elasticity

In many states, casino gambling is restricted either geographically and/or with a set number of licenses. Thus, while casino gambling revenue has the unique attribute of being the actual base that is taxed, total revenues, unlike many other taxable items, are generated in a supply-constrained environment. In nearly all states except Nevada and New Jersey the number of licenses is limited, and New Jersey restricts casinos to Atlantic City. Given this, casino gambling revenue may change due to demand changes, such as changes in personal income, or supply changes, such as changes in the number of licenses or gambling positions (i.e., number of slots and tables). Failure to account for supply driven changes to revenue will result in biased estimates of the income elasticity of demand.

The basic model used to estimate the long-run elasticity of demand is given by:

$$R_{j,t} = \beta_0 + \beta_1 INC_{j,t} + \beta_2 SLOTS_{j,t} + \beta_3 TABLES_{j,t} + \beta_4 S_t + \varepsilon_{j,t} \quad (1)$$

where $R_{j,t}$ is the natural log of casino gambling revenue for state j at time t, $INC_{j,t}$ is a measure of income, such as the natural log of state personal income, for state j at time t, $SLOTS_{j,t}$ is the natural log of the number of slot machines in state j at time t, $TABLES_{j,t}$ is the natural log of the number of tables games in state j at time t, and S_t represent seasonal

dummies for Spring, Summer, and Fall to account for potential seasonal variation in gambling revenue.

The coefficient on $INC_{j,t}$ will provide the income elasticity of demand, thereby predicting the long-run response of casino revenue to a change in income. $SLOTS_{j,t}$ and $TABLES_{j,t}$, on the other hand, are included to account for revenue changes resulting from changes to the supply of casino gambling, either a new casino, an expanded casino, or a change in the mix of slots versus tables.[10]

Augmented Dickey-Fuller tests of the variables in Equation (1) reveal the variables to be nonstationary. However, both the Engle-Granger (1987) and Johansen (1988) tests reveal a cointegrating relationship amongst the variables in equation (1). Nevertheless, Stock and Watson (1993, 2007) note that statistical inferences from equation (1) may not be valid because of the non-normal distribution of the OLS estimator. To account for this, it is recommended to use the dynamic OLS (DOLS) estimator with heteroskedasticity and autocorrelation consistent (HAC) standard errors. This involves estimating the following equation with Newey-West (1987) standard errors:

$$R_{j,t} = \beta_0 + \beta_1 INC_{j,t} + \beta_2 SLOTS_{j,t} + \beta_3 TABLES_{j,t} + \beta_4 S_t + \sum_{t=-m}^{n} \Delta INC_{j,t} + \varepsilon_{j,t} \qquad (2)$$

where $\Delta INC_{j,t}$ is the change in the natural log of income with the number of lags and leads determined using the Bayesian Information Criterion (Stock and Watson, 2007).

[10] Changing the mix of games can have substantial impacts on revenues. In the United States, casinos earn between 70 and 80 percent of their revenue from slot machines.

Short-Run Elasticity

Following Bruce, Fox, and Tuttle (2006), short-run elasticity estimates are derived from an Error-Correction Model (ECM) allowing for asymmetric income elasticity and adjustment to equilibrium. Thus, in the short-run, changes to the gambling revenue base may come from changes in income or an adjustment toward the long-run cointegrating relationship derived from equation (2), both of which may differ depending on whether the actual base is above or below the long-run value. Moreover, for reasons described above, the tax base may change due to supply characteristics, particularly a change to the number of slot machines or table games. Consequently, short-run elasticities are estimated using the following model:

$$\begin{aligned}\Delta R_{j,t} = \beta_0 + \beta_1 \Delta INC_{j,t} + \beta_2 \Delta SLOTS_{j,t} + \beta_3 \Delta TABLES_{j,t} + \beta_4 S_t + \\ \beta_5 (D_{j,t} * \Delta INC_{j,t}) + \beta_6 \varepsilon_{j,t-1} + \beta_7 (D_{j,t-1} * \varepsilon_{j,t-1}) + \mu_{j,t}\end{aligned} \quad (3)$$

where variables are described as above and $D_{j,t}=1$ if $\varepsilon_{j,t} > 0$ in equation (2) above. $\varepsilon_{j,t-1}$ is the error correction term and β_6 captures the adjustment in period t to the disequilibrium in period t-1, i.e., the difference between the last period's actual tax base and the long-run cointegrating relationship predicted by equation (2). The inclusion of the interaction term, $D_{j,t-1}*\varepsilon_{j,t-1}$, allows for this adjustment to differ depending on whether the actual tax base is above or below its long-run value.[11]

[11] Ideally the dummy variable $D_{j,t}$ would equal one during recessions to examine the impact over the business cycle. However, the only recession over the time period studied was between March and November 2001, yielding too few observations to determine casino gambling's resilience to a recession.

Data

The data used to estimate equations (2) and (3) above consist of real quarterly gross casino revenue for eleven states: Colorado, Connecticut, Louisiana, Illinois, Indiana, Iowa, Mississippi, Missouri, Nevada, New Jersey, and South Dakota.[12] Each of these states vary dramatically in their competitive environment, tax structure, and size.[13] Nevada, for example, is the largest and most competitive state, with gross revenues statewide exceeding $12.7 billion dollars in fiscal year 2006 from hundreds of casinos.[14] South Dakota, in contrast, had fiscal year 2006 revenues of $85 million, derived from approximately 3,100 gambling devices (slots and tables) all located in one community, Deadwood, South Dakota.[15]

Most casinos across the United States operate in a supply-constrained environment. In Colorado, casinos are restricted to three former mining towns: Black Hawk, Central City, and Cripple Creek. Iowa, Illinois, Missouri, and Indiana restrict the number of casino licenses issued, and casinos are required to be on water or at pari-mutuel racetracks.

Unlike most other industries, casinos are taxed based on their gross *revenue* rather than profit. Tax rates on casino revenue vary dramatically, from a top tax rate in Nevada of 6.75% on gross revenue, to 50% on gross revenue in Illinois.

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[12] All revenue data are thousands 2006 first quarter dollars, adjusted using the CPI.
[13] Our analysis only includes traditional, privately-owned casinos. We exclude states such as Delaware, Rhode Island, and West Virginia which have video lottery terminals (VLTs) at racetracks that are operated by the state lottery. While VLTs are similar to slot machines, they are controlled in a monopoly environment by the state lottery, and hence distinct from the traditional casinos that have expanded across the country. Moreover, VLT data are difficult to obtain and the expansion of VLTs is relatively recent, limiting the number of available observations .
[14] Data from Nevada available at http://gaming.nv.gov/.
[15] Data from South Dakota only include casino revenue from Deadwood and are available at http://www.state.sd.us/drr2/reg/gaming/. These data do not include revenue from VLT machines run by the lottery and scattered across the state.

Given the variation across states, we estimate state-specific elasticities. Moreover, to our knowledge, this is the first study to have data on the actual tax base. Previous studies, for example, have had to estimate taxable sales or taxable income using national (Sobel and Holcombe, 1996) or state-specific (Bruce, Fox, and Tuttle, 2006) proxies. In the case of casino gambling, however, the taxable gross revenue base is publicly available.

Income data consists of real state, regional, or national income, expressed in millions of 2006:Q1 dollars. Income data are gathered from the Bureau of Economic Analysis. Data on slots and tables, where available, are gathered from various state gambling control boards and commissions. Summary statistics on the regression variables are given in Table 1.

4. Empirical Results

Table 2 provides long-run income elasticity estimates for casino gambling. The results are organized by the type of industry structure in which the casinos operate. For example, destination resort casinos are tourist destinations that offer many amenities including hotels, restaurants, entertainment, and usually contain multiple casinos in a single location. Mississippi is also included in this category, mostly to account for Biloxi/Gulfport and Tunica, although it also has characteristics that are common with the next category, Riverboat Casinos (Vicksburg, Greenville). Riverboat casinos are usually single casinos located near or on a river. These are mostly attractive to residents living nearby the casino, usually within 50 miles. South Dakota and Colorado have casinos that are located in former mining towns and are generally smaller scale operations than Riverboat casinos. Finally, Connecticut has Indian casinos, although both Foxwoods and

Mohegan Sun offer many of the amenities that are offered in Las Vegas and Atlantic City, the only exception being both are single casino operations rather than multiple casino "strips".[16]

Before discussing the results, it is important to note that data on the number of slot machines or tables were not available for Louisiana and New Jersey. To account for supply induced impacts on revenue, dummy variables were used to account for significant legislative and regulatory changes which would logically result in an expansion of gambling. For example, in Louisiana dummy variables are used to account for the offering of video poker machines outside of casinos (beginning 1997:q3), opening of a land-based casino in New Orleans (beginning 1999:q4), and the introduction of slot machines at racetracks (beginning 2002:q2). In New Jersey, prior to July 1991, slot machines, which generate approximately 70-80% of all casino revenue, were restricted to no more than 45% of total casino floor space. After July 1991, this was allowed to increase to a maximum of 75%. A dummy variable equal to one after 1991:q3 is used to capture this expansion of slot machines.

Lastly, the sample period over which the above regressions are run varies by state, with Nevada having the largest sample size (1983:q2-2006:q2) and Indiana having the smallest (1997:q1-2006:q2). The period when casinos are first legalized results in remarkable growth in casino revenue as new casinos open. To avoid the bias this growth could introduce to the long-run estimates, starting dates for each state omit the early quarters of operation. Specifically, starting dates are selected using Hansen's (1992) test

[16] Foxwoods and Mohegan Sun are two of the most successful casinos in the United States and are not representative of typical Indian casinos. Each has annual slot revenues exceeding $1 billion. Table revenues are not publicly reported.

of model stability, with the sample size consisting of the maximum possible number of observations that enables the null hypothesis of model stability not to be rejected.

Table 2 provides DOLS estimates of the long-run elasticity of gambling revenue along with Newey-West standard errors. Also included for comparison purposes are the long-run elasticities for sales and income taxes taken from Bruce, Fox, and Tuttle (2006) or Holcombe and Sobel (1997). All long-run elasticities are statistically significant with the exception of Indiana.[17]

The results in Table 2 suggest that older jurisdictions such as Nevada and New Jersey have much lower long-run elasticities than the other jurisdictions. This most likely reflects their relative maturity (Nevada legalized gambling in 1931, New Jersey in 1976) and larger size.

Of all the states examined, Nevada is the most unique. Its total casino revenues are twice that of Atlantic City, New Jersey, the second largest market in the country. Of all jurisdictions, Nevada, particularly Las Vegas, is the only one that would be considered a national, and even international, destination. The other destination resort communities, Atlantic City and Mississippi, are primarily regional destinations (Garrett and Nichols, forthcoming). This is reflected in the long-run elasticity with respect to national income. Whereas for most states the national income elasticity is less than or equal to the state income elasticity, for Nevada the national income elasticity is nearly twice as large as the state income elasticity, and the difference is statistically significant. This suggests that

[17] The result for Indiana is not likely a function of the smaller sample size. Many states (Iowa, Illinois, Louisiana, and Connecticut) consist of only 5 more observations. More probable is the fact that quarter over quarter growth in real casino revenue in Indiana averaged only 3.1% from 1998-2006, falling to 1.4% from 1999-2006.

Nevada's casino industry is more dependent on growth in national income than are the other state's casinos.

With the exception of Nevada, New Jersey, and Missouri, all long-run income elasticities are statistically equal to one. Therefore, state governments can generally predict that casino revenue, and hence tax revenue, will grow at roughly the same rate as state income.

How do casino gambling taxes compare with a state's traditional tax bases of sales and income? Table 2 includes estimates of sales and income tax elasticities from Bruce, Fox, and Tuttle (2006) or Holcombe and Sobel (1997). In general, the elasticity of the casino gambling tax lies in between the sales and income tax elasticities. The exceptions are Nevada and New Jersey, where the casino gambling taxes are less than the sales tax, and Illinois and Connecticut, where the gambling taxes are greater than the income tax, although not statistically so.

Short-Run Elasticity Estimates

Table 3 provides short-run elasticity estimates for state income. Specifically, it provides estimates of equation (3) allowing for differences in the short-run income elasticity and rate of adjustment depending on whether actual casino gambling revenue is above or below its long-run potential. It also provides estimates assuming symmetric elasticity and adjustment.

The results in Table 3 demonstrate the importance of allowing for different short-run responses depending on whether the tax base is above or below its long-run potential. For example, with no asymmetry, Nevada's short-run elasticity is 0.114 and statistically

insignificant. Based on this estimate, one would conclude that Nevada's casino revenue experiences very little variability. Moreover, the error-correction term estimate of -0.74 indicates that 74% of any gap is closed in one quarter. However, when examining the asymmetric estimates, one finds that the range in the values of the short-run elasticity is relatively large (-0.95 to 1.53). Moreover, the negative value for the below long-run equilibrium estimate suggests a short-run countercyclical response to any change in income. While it remains true that practically all of any gap is closed within one quarter, the conclusions reached are quite different.

All states, with the exception of Louisiana, have short-run elasticity estimates that are statistically different from each other depending on whether the actual tax base is above or below its long-run potential. Likewise, as found by Bruce, Fox, and Tuttle (2006) when examining sales and income tax bases, the short-run elasticity when revenue is above its potential exceeds the elasticity when it is below, with the exception of Indiana. As with the long-run elasticity estimates, the short-run elasticity estimates for casino gambling, on average, lie in-between the short-run elasticity estimates for sales and income taxes. Specifically, the average below-equilibrium value for casino gambling with respect to state income (-0.37) is larger (in absolute value) than those found by Bruce, Fox, and Tuttle (2006) for sales (0.149) and income (0.217), whereas the average above-equilibrium value for casino gambling (1.57) is smaller (1.804 and 2.663 for sales and income, respectively).[18]

The adjustment parameters vary substantially across states. For example, in five states (Mississippi, Louisiana, Colorado, South Dakota, and Connecticut) the above and

[18] Based on the non-asymmetric estimates, the average short-run elasticity for casino gambling is 0.689, which is smaller than the average estimates of sales (.968) and income (1.19) found by Holcombe and Sobel (1997).

below-equilibrium adjustment rates are statistically identical, whereas in three states (Nevada, New Jersey, and Indiana) the above-equilibrium adjustment parameter exceeds, in absolute value, the below-equilibrium value. In the remaining states (Iowa, Illinois, and Missouri), the below-equilibrium adjustment is greater in absolute value.

It is difficult to generalize the estimates in Table 3, but it is interesting to note that the adjustment to equilibrium estimates are statistically significant in all cases when current revenues are below equilibrium with the exception of Louisiana and Indiana. In contrast, less than half of the above equilibrium estimates are significant. This suggests that casino gambling revenues are quicker to recover when below potential than they are to decline when above, a fact that may be beneficial for a state seeking to reduce downside risk in its tax base.

Tables 4 and 5 show short-run elasticities for regional income and national income, respectively. While results are generally similar to those in Table 3, the range of values for the short-run elasticity estimates are significantly greater in Tables 4 and 5, suggesting greater variability in gambling revenues for changes in regional or national income relative to state income. Thus, by adopting casino gambling as a tax base, states may be increasing their exposure to variability in regional and national economic conditions.

A comparison of the long-run elasticity estimates in Table 2 with the short-run results in Table 3 doesn't reveal any distinct pattern. Hence, there is no evidence of a trade-off between growth and variability in casino revenues. This is in line with the findings from Dye and McGuire (1991) and Holcombe and Sobel (1997), which we discussed in Section 2.

Response to the Economic Shocks of 2001

The analysis above examined how casino gambling revenues grow and vary with changes in state, regional, and national income. Over most of the sample period, however, positive economic growth was the norm, limiting the ability to examine how casino gambling revenues behave in a recession or severe economic downturn. The only exception is the recession that occurred from March to November 2001, which clearly was exacerbated by the terrorist attacks of September 11, 2001. While such a short-lived and relatively shallow recession limits the ability to examine casino gambling's resilience to an economic downturn in the context of the error-correction model used above (where the dummy variable in equation 3 would equal 1 during a recession—see footnote 11), we can examine the growth rates of casino gambling revenues during the time surrounding these events.

Dye (2004) found a significant negative response in both state personal income and state tax revenues resulting from the 2001 recession. In particular, when examining the percentage change in per capita total tax revenues from the previous fiscal year, Dye (2004) found that 27 states experienced per capita tax revenue declines in Fiscal Year (FY) 2001. However, by FY 2002 this had increased to 46 states, with 39 states still experiencing per capita tax revenue declines in Fiscal Year 2003.

Table 6 reports the change in per capita gambling revenue from the previous period for fiscal years 2000-2003, providing insight into how casino gambling revenue behaves during a downturn relative to other sources of tax revenue. Several noticeable patterns emerge from Table 6. Firstly, gambling revenue was, on average, less impacted

by the shocks of 2001 than other sources of tax revenue. For FY 2002 six states (Nevada, New Jersey, Mississippi, Iowa, Illinois, and Colorado) experienced a decline in per capita gambling revenue, whereas five (Missouri, Louisiana, Indiana, South Dakota, and Connecticut) experienced an increase, a notable pattern given that 46 of 50 states experienced a decline in overall revenue, including all five of those that experienced growth in gambling revenue. Secondly, when gambling revenue does decline it is, on average, less than the decline in other revenues. Dye(2004) reports that growth in real state tax revenues for FY 2001 was 1%, with a standard deviation of 3.9%. FY 2002, in contrast, had a decline of 4.9%, with a standard deviation of 5.3%. The corresponding figures for casino gambling revenue, in contrast, are growth of 4.69% (standard deviation of 6.98%) and a decline of 0.14% (standard deviation of 3.74%). This is consistent with our finding that casino gambling revenue recovers more quickly when below its long-run potential. Lastly, the impact of the shocks of 2001 was not uniform across states. Destination resort states, particularly Nevada, were more negatively impacted than other communities. Revenue growth for Nevada was negative in fiscal years 2000-2002, and only 0.2% in FY 2003. Although not as pronounced, New Jersey and Mississippi follow similar patterns, with the notable exception of New Jersey's greater recovery in FY 2003. These results likely reflect the negative impact of September 11 on these tourist-oriented markets, making generalizations about the impact of an economic downturn difficult.

5. Concluding Remarks

The current study examined the long and short-run income elasticity estimates of casino gambling revenue, a tax base that has been increasingly adopted by states seeking other sources of tax revenue. The long-run growth estimates suggest that casino

gambling as a tax base is more similar to personal income than taxable sales, although most estimates fall between these traditional tax bases. Results from the more mature markets of Nevada and Atlantic City, however, suggest that casino revenue growth may be limited, as these states have long-run growth estimates below their corresponding sales tax estimates. This is something states should consider as they consider the long-run configuration of their tax base portfolios and consider the expansion of casino gambling.

The short-run elasticity estimates are more difficult to generalize, but several interesting findings stand out. First, when accounting for short-term variability it is critical to allow for asymmetric elasticities and adjustments. Failure to do so may lead to erroneous conclusions about stability. Demonstrating this most clearly was the case of Nevada where the range in below and above-equilibrium estimates was greatest when allowing for asymmetry but averaged out to be small and insignificant when failing to do so. Second, casino revenue, much like income and taxable sales, has a greater response to changes in income when above its long-run equilibrium. Third, casino gambling revenue's adjustment to the long-run equilibrium is faster when revenues are below their long-run potential. This rapid recovery from an economic downturn should make casino gambling appealing to states seeking to refill the tax coffers. Finally, there is evidence of greater variability in gambling revenues when regional or national income changes are taken into consideration. This suggests that states that depend heavily on out-of-state visitors in their gambling operations may be more susceptible to changes in regional or national economic activity.

The current study, although limited strictly to casino gambling, is unique in that the estimates derived are generated from the actual tax base rather than a proxy thereof.

This is the first study to our knowledge to do so. Moreover, this is one of the few studies to provide income elasticity estimates for casino gambling. This is important as states and countries around the world continue to look to casino gambling as a source of tax revenue and a means of diversifying their tax base.

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Table 1. Summary Statistics of Variables Used in the Analysis

	Observations	Mean	Standard Deviation
Real National Personal Income (millions $)	93	8,237,421	1,371,210
Nevada			
Real Casino Revenue (thousands $)	93	2,247,900	457,459
Real State Personal Income (millions $)	93	52,379	20,235
Real Regional Personal Income (millions $)	93	1,435,861	263,219
Number of Slots	89	148,923	34,654
Number of Table Games	89	536	101
New Jersey			
Real Casino Revenue (thousands $)	85	1,170,699	126,714
Real State Personal Income (millions $)	85	320,945	44,251
Real Regional Personal Income (millions $)	85	1,618,571	186,585
Number of Slots		N/A	N/A
Number of Table Games		N/A	N/A
Mississippi			
Real Casino Revenue (thousands $)	43	690,074	86,296
Real State Personal Income (millions $)	43	67,664	4,528
Real Regional Personal Income (millions $)	43	2,057,410	184,427
Number of Slots	43	37,167	4,160
Number of Table Games	43	1,304	183
Iowa			
Real Casino Revenue (thousands $)	44	251,176	32,112
Real State Personal Income (millions $)	44	89,440	5,106
Real Regional Personal Income (millions $)	44	621,450	42,962
Number of Slots	44	7,770	1,418
Number of Table Games	44	288	45
Illinois			
Real Casino Revenue (thousands $)	44	429,442	65,838
Real State Personal Income (millions $)	44	447,835	24,200
Real Regional Personal Income (millions $)	44	1,497,365	75,415
Number of Slots	44	8,966	775
Number of Table Games	44	333	86
Missouri			
Real Casino Revenue (thousands $)	46	295,877	79,378
Real State Personal Income (millions $)	46	68,514	4,775
Real Regional Personal Income (millions $)	46	617,439	46,102
Number of Slots	46	14,445	3,804
Number of Table Games	46	533	125
Louisiana			
Real Casino Revenue (thousands $)	40	605,238	124,927
Real State Personal Income (millions $)	40	119,971	6,303
Real Regional Personal Income (millions $)	40	2,080,044	170,576
Number of Slots		N/A	N/A
Number of Table Games		N/A	N/A

Table 1. Cont'd

	Observations	Mean	Standard Deviation
Indiana			
Real Casino Revenue (thousands $)	38	200,315	17,640
Real State Personal Income (millions $)	38	189,569	8,454
Real Regional Personal Income (millions $)	38	1,520,242	51,304
Number of Slots	38	15,569	2,841
Number of Table Games	38	630	66
Colorado			
Real Casino Revenue (thousands $)	53	159,975	35,152
Real State Personal Income (millions $)	53	150,595	23,808
Real Regional Personal Income (millions $)	53	283,614	40,714
Number of Slots	53	13,874	1,718
Number of Table Games		N/A	N/A
South Dakota			
Real Casino Revenue (thousands $)	65	15,853	4,374
Real State Personal Income (millions $)	65	21,210	2,836
Real Regional Personal Income (millions $)	65	583,436	66,077
Number of Slots	65	2,377	437
Number of Table Games	65	76	17
Connecticut			
Real Casino Revenue (thousands $)	44	363,627	79,417
Real State Personal Income (millions $)	44	157,281	11,637
Real Regional Personal Income (millions $)	44	559,475	44,997
Number of Slots	44	9,980	3,046
Number of Table Games		N/A	N/A

Table 2. Long-Run State, Regional, and National Income Elasticity Estimates for Casino Revenue & Long Run State Income Elasticity for Sales and Income Tax

	State Income	Regional Income	National Income	Sales Tax	Income Tax
Destination Resorts					
Nevada	0.22***	0.36***	0.40***	0.78**	1.03***
(1983:q2-2006:q2)	(0.036)	(0.068)	(0.073)		
New Jersey	0.38***	0.46***	0.35***	1.05**	2.01**
(1985:q1:2006:q2)	(0.05)	(0.06)	(0.05)		
Mississippi	1.40**	0.78*	1.16***	0.48**	1.91**
(1994:q4-2005:q2)	(0.55)	(0.41)	(0.40)		
Riverboat Casinos					
Iowa	0.91***	1.17***	0.79***	0.37**	2.35**
(1995:q3-2006:q2)	(0.25)	(0.18)	(0.18)		
Illinois	1.85**	2.29***	1.94***	0.87**	1.56**
(1995:q3-2006:q2)	(0.77)	(0.68)	(0.61)		
Missouri	2.04***	2.05***	1.67***	0.64**	2.29**
(1995:q1-2006:q2)	(0.31)	(0.19)	(0.18)		
Louisiana	1.36***	0.66**	0.69**	0.51**	2.27**
(1995:q3-2005:q2)	(0.17)	(0.25)	(0.29)		
Indiana	0.51	0.08	-0.15	0.47***	2.43**
(1997:q1-2006:q2)	(0.35)	(0.45)	(0.18)		
Mining Towns					
Colorado	1.05***	1.14***	1.25***	0.78**	1.26**
(1993:q2-2006:q2)	(0.14)	(0.21)	(0.32)		
South Dakota	0.99***	1.08***	1.00***	1.145**	1.030***
(1990:q2-2006:q2)	(0.16)	(0.21)	(0.17)		
Indian Casinos					
Connecticut	1.34***	1.25***	1.04***	1.24**	0.96***
(1995:q3-2006:q2)	(0.24)	(0.21)	(0.37)		

A *, **, and *** represent significance from zero at the 10, 5, and 1 percent level, respectively. Newey-West standard errors in parentheses. Income and sales tax elasticities are taken from Tuttle, Bruce, and Fox (2006) and Holcombe and Sobel (1997). Elasticities from Holcombe and Sobel (1997) are used for Indiana (sales tax), and Nevada, South Dakota and Connecticut (income tax).

Table 3. Short-Run State Income Elasticity and Adjustment to Equilibrium Estimates

			Short-Run Elasticity		Adjustment to Equilibrium	
	Short-Run Elasticity	Adjustment to Equilibrium	Current Revenue Below Long-Run Equilibrium	Current Revenue Above Long-Run Equilibrium	Current Revenue Below Long-Run Equilibrium	Current Revenue Above Long-Run Equilibrium
Destination Resorts						
Nevada	0.114	-0.741***	-0.95***	1.53***	-0.70***	-1.19***
	(0.40)	(0.119)	(0.343)	(0.356)	(0.177)	(0.172)
New Jersey	1.05***	-0.402***	0.39	1.89***	-0.26*	-0.72***
	(0.27)	(0.08)	(0.36)	(0.40)	(0.15)	(0.18)
Mississippi	-1.20	-0.273**	-2.69**	0.18	-.49**	-0.28
	(0.84)	(0.12)	(1.13)	(1.11)	(0.22)	(0.26)
Riverboat Casinos						
Iowa	1.29***	-0.99***	0.16	1.78***	-1.03***	-0.30
	(0.41)	(0.04)	(0.49)	(0.52)	(0.04)	(0.24)
Illinois	-0.297	-0.161*	-3.33**	0.92	-0.48**	-0.15
	(1.02)	(0.08)	(1.52)	(1.27)	(0.19)	(0.14)
Missouri	1.27***	-0.633***	0.60	2.26***	-0.85***	-0.001
	(0.41)	(0.13)	(0.46)	(0.67)	(0.18)	(0.29)
Louisiana	1.82	-0.776	-0.61	2.32	-0.33	-2.05
	(1.43)	(0.50)	(2.10)	(1.85)	(0.80)	(1.27)
Indiana	1.95***	-0.591***	2.87**	1.49**	-0.28	-1.05***
	(0.62)	(0.14)	(1.08)	(0.73)	(0.25)	(0.35)
Mining Towns						
Colorado	0.86**	-0.394***	0.30	1.58***	-0.48***	-0.43*
	(0.42)	(0.095)	(0.51)	(0.57)	(0.15)	(0.23)
South Dakota	-.276	-0.433***	-1.19	1.35	-0.40*	-0.48**
	(0.64)	(0.10)	(0.75)	(0.97)	(0.23)	(0.22)
Indian Casinos						
Connecticut	1.00*	-0.188*	-0.94	2.05***	-0.39*	-0.29
	(0.55)	(0.11)	(0.84)	(0.62)	(0.20)	(0.21)

A *, **, and *** represent significance from zero at the 10, 5, and 1 percent level, respectively.

Table 4. Short-Run Regional Income Elasticity and Adjustment to Equilibrium Estimates

			Short-Run Elasticity		Adjustment to Equilibrium	
	Short-Run Elasticity	Adjustment to Equilibrium	Current Revenue Below Long-Run Equilibrium	Current Revenue Above Long-Run Equilibrium	Current Revenue Below Long-Run Equilibrium	Current Revenue Above Long-Run Equilibrium
Destination Resorts						
Nevada	0.407	-0.77***	-0.84*	1.77***	-0.62***	-1.14***
	(0.30)	(0.12)	(0.44)	(0.44)	(0.21)	(0.19)
New Jersey	0.762**	-.413***	0.10	1.75***	-0.32**	-0.65***
	(0.32)	(0.09)	(0.40)	(0.48)	(0.16)	(0.20)
Mississippi	-0.64	-.244*	-2.33**	2.44*	-0.60***	-0.37
	(1.14)	(0.13)	(1.17)	(1.45)	(0.20)	(0.24)
Riverboat Casinos						
Iowa	2.38***	-0.986***	1.41**	3.66***	-1.01***	-0.42*
	(0.66)	(0.04)	(0.64)	(0.74)	(0.03)	(0.25)
Illinois	0.166	-0.154	-2.98**	2.00	-0.60***	-0.05
	(1.12)	(0.09)	(1.43)	(1.39)	(0.20)	(0.15)
Missouri	2.055***	-0.651***	0.75	2.65***	-0.83***	-0.21
	(0.85)	(0.13)	(1.15)	(0.93)	(0.15)	(0.32)
Louisiana	2.041	-.548	-0.11	4.07	-0.69	-0.96
	(2.40)	(0.44)	(2.86)	(2.91)	(0.69)	(1.03)
Indiana	1.965**	-.602***	2.19	1.80*	-0.30	-1.08***
	(0.79)	(0.15)	(1.40)	(0.93)	(0.26)	(0.36)
Mining Towns						
Colorado	1.141**	-0.299***	0.31	2.21***	-0.42***	-0.35
	(0.56)	(0.08)	(0.67)	(0.71)	(0.14)	(0.24)
South Dakota	0.341	-0.399***	-2.52*	2.39*	-0.37*	-0.55***
	(1.01)	(0.10)	(1.45)	(1.24)	(0.20)	(0.22)
Indian Casinos						
Connecticut	1.110*	-0.200*	-1.66	1.62**	-0.45**	-0.22
	(0.60)	(0.11)	(1.20)	(0.60)	(0.21)	(0.21)

A *, **, and *** represent significance from zero at the 10, 5, and 1 percent level, respectively.

Table 5. Short-Run National Income Elasticity and Adjustment to Equilibrium Estimates

			Short-Run Elasticity		Adjustment to Equilibrium	
	Short-Run Elasticity	Adjustment to Equilibrium	Current Revenue Below Long-Run Equilibrium	Current Revenue Above Long-Run Equilibrium	Current Revenue Below Long-Run Equilibrium	Current Revenue Above Long-Run Equilibrium
Destination Resorts						
Nevada	0.17	-0.77***	-1.37***	1.89***	-0.62***	-1.18***
	(0.47)	(0.13)	(0.51)	(0.50)	(0.21)	(0.19)
New Jersey	1.29***	-.376***	-0.27	2.81***	-0.29**	-0.72***
	(0.42)	(0.08)	(0.50)	(0.48)	(0.13)	(0.16)
Mississippi	-0.275	-.298**	-2.07*	1.85	-0.54**	-0.46
	(0.95)	(0.13)	(1.09)	(1.18)	(0.21)	(0.28)
Riverboat Casinos						
Iowa	2.30***	-0.978***	0.69	2.59***	-1.01***	-0.44***
	(0.68)	(0.04)	(0.87)	(0.66)	(0.03)	(0.26)
Illinois	0.601	-0.105	-2.49*	2.76*	-0.41**	-0.19
	(1.18)	(0.097)	(1.44)	(1.40)	(0.19)	(0.16)
Missouri	1.282	-0.575***	0.25	2.48**	-0.84***	-0.04
	(0.91)	(0.12)	(1.11)	(0.95)	(0.15)	(0.30)
Louisiana	1.585	-.589	-0.08	5.15	-0.61	-1.20
	(2.10)	(0.43)	(2.30)	(3.06)	(0.64)	(0.93)
Indiana	1.190	-0.623***	-0.58	1.53	-0.52*	-0.75*
	(0.88)	(0.16)	(1.45)	(0.91)	(0.27)	(0.42)
Mining Towns						
Colorado	1.261	-0.229**	-0.26	3.06***	-0.41***	-0.21
	(0.77)	(0.09)	(0.89)	(0.93)	(0.15)	(0.20)
South Dakota	1.46	-0.419***	-2.02	3.18***	-0.39*	-0.61**
	(1.06)	(0.10)	(1.61)	(1.19)	(0.20)	(0.24)
Indian Casinos						
Connecticut	2.109***	-0.142	0.17	3.37***	-0.32*	-0.26
	(0.77)	(0.087)	(1.00)	(0.87)	(0.18)	(0.18)

A *, **, and *** represent significance from zero at the 10, 5, and 1 percent level, respectively.

Table 6. Fiscal Year Per Capita Gambling Revenue Growth Rate (Percent Change from Previous Fiscal Year)

	FY 2000	FY 2001	FY2002	FY 2003
Destination Resorts				
Nevada	-5.26	-8.90	-2.75	0.20
New Jersey	-3.70	-0.60	-3.40	5.10
Mississippi	-2.70	0.6	-3.20	0.10
Average	-3.88	-2.96	-3.12	1.80
Riverboat Casinos				
Iowa	-2.74	6.20	-0.20	4.70
Illinois	3.52	4.55	-4.59	-10.62
Missouri	2.78	12.82	4.66	4.60
Louisiana	7.65	5.22	1.30	1.50
Indiana	-5.97	1.20	6.80	-2.10
Average	1.04	5.99	1.59	-0.38
Mining Towns				
Colorado	3.21	4.48	-3.70	-2.72
South Dakota	-1.16	17.40	1.90	7.85
Average	1.03	10.94	-0.9	2.56
Indian Casinos				
Connecticut	-0.70	8.70	1.60	0.96
Average	-0.46	4.69	-0.14	0.87

Source: Computed by the authors.