

Casino Revenue Sensitivity to Competing Casinos: A Spatial Analysis of Missouri

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ABSTRACT Previous studies have examined the relationships among different gambling industries (e.g., casinos, lotteries, and racetracks), with mixed results. Yet, the literature lacks evidence on the extent to which casinos in a particular market compete with each other. No study considers the proximity of competing casinos in its empirical analysis. This analysis uses quarterly casino property-level revenue data from Missouri, 1997.1–2010.2, and a model with a distance-adjusted competition scalar to analyze how competing casinos affect the revenues of a particular casino. The results indicate that machine games, table games, and square footage all have a positive effect on own-casino revenues. Machine games and square footage have a negative impact on competing casinos; however, table games have a positive impact on competing casinos. These results are consistent with how the Missouri casino industry is developing, with more emphasis on machine games and less on table games. The results suggest that casinos are competitive in nature (i.e., are substitutes), as there is no evidence to suggest that there is any positive agglomeration effect from casinos being clustered. This analysis should be of interest to industry and policy makers, and provides a foundation for further research on the U.S. casino industry.

Introduction

Since the late 1980s, state governments have been legalizing commercial casinos as a strategy to promote employment, tax revenues, and economic growth. Although there still has not been much academic research on the economic impacts of casinos, there is some evidence that casinos do promote economic growth and employment (Cotti 2008; Walker and Jackson 2012). Casinos have become widespread in the U.S. By the end of 2011, the U.S. had over 900 commercial and tribal casinos and at least 47 racetrack casinos (“racinos”) operating in 38 states (AGA 2012).

State government interest in legalizing or expanding commercial casinos increased upon the onset of the recession in late 2007. Kansas, Ohio, and Massachusetts have legalized casinos, and several other states are in the process of doing so or of expanding their existing industries. Total national industry revenues continue to increase as the number of casinos increases (AGA 2012).¹

Despite the apparent importance of casinos as a part of state governments’ fiscal policies, little research has been published on the intra-industry relationships among

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casinos. It is not obvious whether casinos complement each other through an agglomeration effect, or whether they act as substitutes to each other. The casinos in Las Vegas, Atlantic City, and Biloxi certainly benefit from being clustered. Yet, most states to legalize casinos recently have followed a “regional model”—allowing only one casino in each region of the state (e.g., Kansas, Ohio, and Massachusetts). Clearly, the intra-industry relationship between casinos is an important issue, given that politicians in each state explicitly control the size and locations of casinos.

As an indication of the importance of the issue, consider that the Missouri Gaming Commission invited a policy analysis of the likely impact of introducing a thirteenth casino into the state’s existing market. The 2010 report suggested that the smaller and more isolated the casino, the more positive its effects would be on employment, gaming revenues, and tax revenues for the state (Missouri Economic Research and Information Center 2010).

Interestingly, the Missouri Economic Research and Information Center (MERIC) report asserts that because the Kansas City casinos are in close proximity to each other (within 5 miles of each other), “any new casino located near existing competitors in Kansas City will cannibalize [adjusted gross revenue] to a high degree” (Missouri Economic Research and Information Center 2010). In one “best case” scenario estimate of a new casino development in an urban Missouri casino market, the model still assumes cannibalization among casinos. “No cannibalization” is only considered to be a possibility if a casino is isolated from other casinos. Any agglomeration benefit from casinos clustering is not acknowledged. Yet, this assumption that casinos must be competitors and not complementary (in terms of revenues) seems inconsistent with several mature casino markets which have seen net growth even as the number of casinos in the market increased. Obvious examples include Las Vegas, Biloxi, and perhaps even the Kansas City and St. Louis markets.

The purpose of this study is to test whether relative casino location and competing casino size affect a particular casino’s revenue. The empirical analysis helps address the inter-industry relationship among casinos and may be informative as to whether a “clustered” or “regional” strategy is better for locating casinos. The results indicate that increased regional competition—through increased machine games and/or square footage of competing casinos, or through reduced distance to competing casinos—has a negative impact on a particular casino’s revenues. The analysis focuses on Missouri, but the model could be applied to other states, regions, and countries. An understanding of how sensitive a casino’s revenues are to other casinos’ locations and sizes should be valuable to the casino industry, policy makers, voters, and regulators debating whether to introduce casinos or to expand existing casino markets.

The paper is organized as follows. The remainder of this section briefly reviews the literature. A description of the Missouri casino market and the data used in the analysis can be found in the next section. We then explain the model and present the results. The next section discusses the predicted impact of a new casino in the Missouri market. A

robustness check of the ordinary least square (OLS) model follows. We then summarize and conclude.

Literature review. Several studies have examined the determinants of casino legalization. These include Furlong (1998), Calcagno, Walker, and Jackson (2010), Richard (2010), and Wenz (2008). However, none of these studies examines how casino revenues will be impacted by adding a new casino or changing existing casinos' capacities.

There have been a few studies that have directly or indirectly examined inter- and intra-industry relationships among gambling industries, with a particular focus on casinos. Walker and Jackson (2008) found that within a particular state, tribal casino square footage has a positive impact on commercial casino revenues, indicating complementary. However, in testing the impact of adjacent state casinos, they found a negative impact of casino revenues on neighboring state casino revenues, indicating substitution. Although these results are certainly relevant to the issue in this paper, their analysis was aggregated to a national level, using state-level data, rather than property-level data.

Several other papers have examined the substitution issue. Anders, Siegel, and Yacoub (1998) found that Indian casinos harm other forms of entertainment. Elliott and Navin (2002) concluded that casinos and pari-mutuels harm lotteries, whereas Siegel and Anders (1999, 2001) found that casinos harm other forms of entertainment, slot machines harm the lottery, and that pari-mutuels do not affect the lottery.

The study by Thalheimer and Ali (2003) examined slot machine handle at casinos in Iowa, Illinois, and Missouri, from 1991–1998. They model competition among casinos by introducing a variable measuring “ease of access” to casinos from the county's population, which is assumed to be located at the geographical centroid of the county (p. 917). Unsurprisingly, they found that as potential customers' access to casinos increases, the demand for casino gambling increases. In addition, they found that demand at a particular casino decreases when access to competing commercial casinos, racinos, or tribal casinos increases (p. 914).

A recently published study by Condliffe (2012) has examined how the introduction of casinos in Pennsylvania has affected overall revenues in the regional market of southeast Pennsylvania, Delaware, and Atlantic City. He found that the introduction of casinos in Pennsylvania reduces total revenues in the region, and that an increase in the number of slot machines in Pennsylvania reduces overall regional revenues. McGowan's (2009) study, which looks only at Pennsylvania and New Jersey, found that total revenues in the states increased when Pennsylvania introduced casinos. Although these studies did not address the substitution issue directly, they provided interesting analyses of expansion in the Northeast casino market.

Other papers in the literature examined the casino industry, but there is no study that focuses on the property-level relationship between casinos. This study will therefore be a useful contribution to the literature.

Data

In order to test whether (and how) casino revenues depend on the size and proximity of other casinos, one must first specify a market to analyze. Many states that have commercial casinos also have casinos owned by Indian tribes. Since Indian tribes are sovereign nations, their casino revenues are generally not public information. Because of this, a good empirical analysis that focuses on casino revenues is difficult to perform in states that also have tribal casinos. Missouri does not have tribal casinos; it therefore represents an ideal and unique case study for how casinos affect each other. This section provides a background of the Missouri casino industry and presents the data used in the analysis of the market.

Background on Missouri. Missouri was the sixth state in the U.S. to legalize commercial casinos, in 1993, and riverboat casinos began operating there in May 1994 (Calcagno, Walker, and Jackson 2010). As of December 2012, there were 13 commercial casinos operating in the state, with the newest casino opening in late October 2012 (Miller 2012). By state law, Missouri can have a maximum of 13 riverboat casinos (Missouri Economic Research and Information Center 2010). Riverboat casinos were initially required to “cruise” while customers gambled. However, in 1998, the cruising rule was eliminated and now regulations only require that “Missouri riverboat gaming casinos must be located within 1,000 feet of the main channel of the Missouri and Mississippi rivers.” Casinos can now be riverboats, “boats in moats”, or land-based.²

An overview of the Missouri casino market at the end of 2011 is presented in Table 1. The table lists the city/market, casino name, opening date, major changes in ownership, and closures. The four rightmost columns list measures of casino size and activity: adjusted gross revenues (AGR, the revenue the casino keeps after paying winning bets to customers), casino floor area in square feet, and the number of table games and machine games operating in each casino during 2011. “Table games” include baccarat, craps, blackjack, poker, etc. “Machine games” include slot machines, video poker, video lottery terminals, and any other electronic gambling devices. Note that Table 1 also lists this information for the two casinos (Sam’s Town and President) that have closed, along with one casino that was merged with another casino (Players Casino merged with Harrah’s Maryland Heights).

The Missouri casino industry has expanded fairly consistently since its birth in 1994. Figure 1 lists the industry revenues by fiscal year and the number of casinos operating in the state for at least half of the fiscal year. Revenues increased at a fairly constant rate for the first 10 years, and more recently at a decreased rate. Revenue growth has slowed during a time when the number of casinos was fairly stable at 11 and 12.

As an industry, legalized gambling is not a very large contributor to U.S. state coffers. Walker and Jackson (2011) showed that in 2004 only four states received more than 5 percent of their government revenues from legalized gambling. In Missouri, 3.3 percent of state revenue is from legalized gambling (2.1 percent from casino taxes, 1.1 percent from lottery receipts). Overall, while casinos may not represent a critical source

TABLE 1. MISSOURI CASINO OVERVIEW.

Market	Property name ^a	Opening date	Major change (date)	2011 fiscal year gross revenues (millions nominal \$)	2011 casino space (sq. ft.)	2011 gaming machines	2011 gaming tables
St. Joseph Kansas City	St Jo Frontier	6/1994	Changed ownership (2/2005)	\$40.2	18,000	550	11
	Argosy	6/1994	—	\$193.1	62,000	1,894	39
	Isle of Capri, KC	10/1996	Changed ownership (7/2000)	\$83.6	45,300	1,163	22
	Harrah's, N KC	9/1994	—	\$193.3	63,300	1,585	62
	Ameristar, KC	1/1997	Changed ownership (12/2000)	\$241.1	140,000	2,840	74
Boonville	Sam's Town	9/1995	Closed (7/1998)	—	28,000 ^b	1,117 ^b	45 ^b
	Isle of Capri, Boonville	12/2001	—	\$82.0	28,000	991	19
LaGrange	Mark Twain	7/2001	Changed ownership (2/2005)	\$38.1	18,000	656	13
Caruthersville	Lady Luck	4/1995	Changed ownership (3/2007)	\$33.3	21,400	595	14
	Ameristar, St Charles	5/1994	Changed ownership (12/2000)	\$278.3	130,000	2,738	72
St. Louis	Harrah's, Maryland Heights	3/1997	Bought neighboring Players Casino (4/2000)	\$269.3	120,000	2,503	86
	Lumière Players	12/2007	—	\$173.2	75,000	2,011	67
President River City	President	3/1997	Bought by Harrahs, MH (4/2000)	—	52,000 ^c	1,586 ^c	48 ^c
	President	5/1994	Closed (6/2010)	\$19.2 ^d	53,800 ^d	674 ^d	7 ^d
	River City	3/2010	—	\$180.9	66,000	2,034	59
Total values for casinos open in 2011				\$1,806.4	811,000	19,560	538

^a The shaded casino names are those included in our dependent variable.

^b Indicates values at the time Sam's Town closed, July 1998.

^c Indicates values at the time Players was bought by neighboring Harrah's Maryland Heights, April 2000.

^d Indicates values at the time President closed, June 2010. The gross revenues reported are for the fiscal year 2010, the last full year of operations. Source: Missouri Gaming Commission annual reports and monthly financial reports.

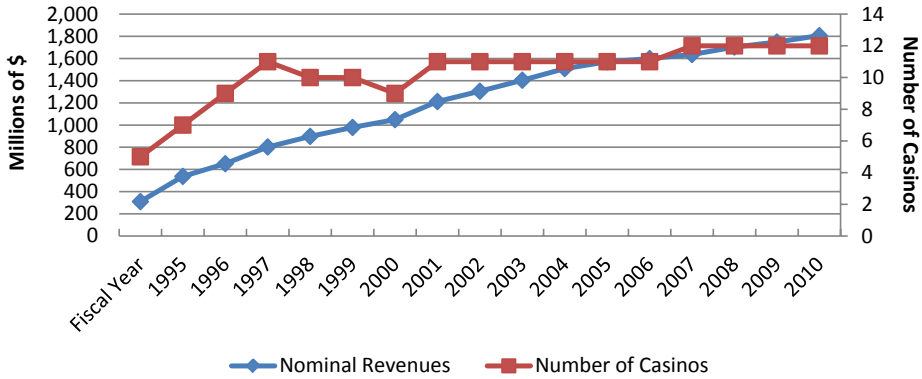


FIGURE 1. MISSOURI CASINO INDUSTRY.

of state revenues, casino taxes do allow politicians to avoid making unpopular decisions, at least at the margin, such as (non-casino) tax increases or spending cuts.

Missouri provides an ideal casino market for our analysis because during the sample period new casinos open, old ones close, and several casinos expand in size at least once. Therefore, it is possible to model how such changes in competition affect any particular casino’s revenues.

When the President Casino in St. Louis closed in 2010, it freed up a license for a new entrant into the market. Policy makers were interested in whether it would benefit the state, or the state’s casino industry, to allow a new casino to open in the place of the President Casino. The state commissioned a study of the likely impacts on existing casinos prior to approving a new casino license. The same issues confronted by Missouri—whether to expand the casino industry, and where a new casino should be located—confront every state with casinos or considering legalizing them. Will adding a new casino to a market improve or worsen overall industry performance and tax receipts? And how do casinos’ relative sizes and locations affect each other? Since this is one of the first papers to analyze these issues, it fills an important gap in the casino literature.

Data. The goal of the analysis is to model how location-specific casino revenues are impacted by changes in regional competition. Regional competition is defined as those casinos, commercial or tribal, operating within 100 miles of each casino. Using this range requires that several casinos outside of Missouri be considered, including casinos in Illinois, Kansas, and one in Iowa. All of the casinos that are included in the analysis are illustrated in Figure 2. Also shown in the figure is Harrah’s Tunica Casino, which lies at the very edge of the 100-mile distance from the Lady Luck Casino in Caruthersville. The Tunica casino is not included in the analysis, but it is shown on the map to give a visual of the next closest casino.³

As noted earlier, the dependent variable is a measure of casino activity: casino property-level AGR.⁴ Casino revenue data were provided by the Missouri Gaming



FIGURE 2. MAP OF MISSOURI CASINOS AND OTHER CASINOS WITHIN 100 MILES.

Commission, and were adjusted for inflation using the CPI. The study uses quarterly revenue data for all Missouri casinos that were open for the entire period from 1997.1 through 2010.2.⁵ This encompasses data on nine casinos for 54 quarters. (These casinos' names are shaded in Table 1.) The purpose of the analysis is to examine how *existing* casinos are affected by other casinos opening, closing, or changing in size. The goal is not to explain revenues for casinos that newly opened or closed down during this time period or to explain why casinos open or close. Therefore, casinos that opened or closed during the sample period are not included in the dependent variable. However, opening and closing casinos' size and location data are included in the relevant explanatory variables.

The explanatory variables in the model include measures of the scale of operation of each casino, measures of regional competition, and regional demographic measures to account for demand. The model considers casinos operating within 100 miles of each

Missouri casino as regional competition. Some competing casinos are located in Kansas, Illinois, and Iowa, and data on these casinos are included with the explanatory variables.⁶ The distances between casinos are calculated “as the crow flies” and are derived using the longitude-latitude coordinates based on the casinos’ physical address, as determined in Arc GIS 9.3. The casinos’ physical addresses are available from CasinoCity (<http://casinocity.com>).

There are two measures of scale. The first is the number of table games and number of machine games at the casino. The second measure is the casino’s square footage. These scale data are reported on an annual basis. The competition measures for each included Missouri casino are computed based on all operating casinos within 100 miles, for each sample year.

Scale data for Illinois casinos are provided by the Illinois Gaming Board’s Annual Reports, 1999–2011.⁷ Kansas casino data come from the Kansas State Gaming Agency (<http://www.accesskansas.org/ksga/>) and CasinoCity. A Kansas State Gaming Agency official confirmed there had been no significant expansions to the casinos in the 100-mile competition region during the sample period, with the exception of that at Sac & Fox, in 2008. Finally, data for the relevant casino in Iowa were collected from the Iowa Racing and Gaming Commission website (<http://www.state.ia.us/irgc/>).

The pairwise distance with each Missouri casino is calculated and used to compute two gravity-model inspired regional competition variables, which are labeled as distance-scaled competition (DSC) for modeling purposes. These variables incorporate both the distance and the competing casino scale in its calculation. Hall, Lawson, and Skipton (2011) used a similarly constructed variable, distance-adjusted demand scalar, to measure “a country’s relative proximity to world concentrations of demand” in their model of international trade. Likewise, Nesbit and Lawson (2012) constructed a distance-scaled tax differential variable in their model of cigarette smuggling.

For each Missouri casino i , data are collected on the number of table games and number of gaming machines for all other j casinos within 100 miles. These measures are scaled individually by $\frac{1}{distance_{i,j}}$ in one specification and by $\frac{1}{distance_{i,j}^2}$ in another, and then the scaled measures are summed. Thus,

$$DSC_i = \sum_{j=1}^m \frac{(Size_j)}{distance_{i,j}} \text{ for all } i = 1, \dots, n \quad (1)$$

$$\text{and } DSC_i = \sum_{j=1}^m \frac{(Size_j)}{distance_{i,j}^2} \text{ for all } i = 1, \dots, n \quad (2)$$

$Size_j$ represents one of the measures of casino size (table games, machine games, square footage). Distance is measured as the “as the crow flies” distance between casinos. An increase in regional competition would be represented by an increase in DSC. This could occur through an increase in the size of a nearby casino (either in square footage,

number of machines, or number of tables), the relocation of an existing casino to a closer venue, or the opening of a new casino within a 100-mile radius.

The remaining demand factors considered include real per capita personal income (*PCPI*), the unemployment rate (*Urate*), and estimated population (*Pop*) in the metropolitan statistical area (MSA) within which a casino is located or that is closest to the casino.⁸ The Kansas City MSA includes five casinos in the analysis; the St. Louis MSA includes six casinos in the analysis. There is one casino in the St. Joseph MSA. The remaining casinos in the state are not in MSAs. Since the goal in using MSA-based data is to represent the local demand for casinos, for the relatively isolated casinos, the closest MSAs are used for the data. Boonville is in the county adjacent to the Columbia MSA. La Grange is closest to the Quincy, IL micropolitan statistical area, and Caruthersville is closest to Dyersburg, TN.⁹

Annual population estimates are from the Census Bureau. Annual unemployment rate data are from the Bureau of Labor Statistics. Annual PCPI data are from the Bureau of Economic Analysis.¹⁰ Personal income data are adjusted for inflation with the CPI.

Model and Results

The goal of the analysis is to determine the extent to which competing casino size and proximity affects a particular casino's revenues. Quarterly real casino revenue at the property level is used as the dependent variable. Explanatory variables include measures of scale of each Missouri casino, measures of competing casinos within 100 miles of each particular casino (*DSC*), and the demographic variables of MSA population, unemployment rate, PCPI, and property-level fixed effects. The model is shown in equation (3):

$$Revenue_{i,t} = \beta_0 + \beta_1 Size_{i,t} + \beta_2 DSC_{i,t} + \beta_3 Pop_{i,t} + \beta_4 PCPI_{i,t} + \beta_5 Urate_{i,t} + \varepsilon_{i,t} \quad (3)$$

The natural log of each variable (except unemployment rate) is used. In addition, the model includes two-way fixed effects.

Four specifications of the model are tested: a pair employing both gaming machines and table games as the casino size and competition variables and another pair of specifications instead employing casino square footage. Within each aforementioned pair, the method by which competition is scaled is varied: first, scaling competition by distance and, second, scaling competition by distance-squared. Two scaling methods are used for the competition variables to not only show robustness but also because theory does not suggest a specific competitive decay function. As will be described more fully below, the choice of the scaling does not significantly impact the qualitative interpretation of our results. The below discussion emphasizes the distance-scaled (rather than distance-squared scaled) results; this choice is largely based on interpretive convenience.

OLS results of the four specifications are presented in Table 2. The results shown are for a two-way (quarter and casino property) fixed effects model. Columns 1 and 2

TABLE 2. ORDINARY LEAST SQUARE TWO-WAY FIXED EFFECTS MODEL FOR LOG(CASINO REVENUE): 1997 Q1–2010 Q2.

Variable	[1]		[2]		[3]		[4]	
	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat
log(Machines)	0.453***	9.112	0.498***	9.994				
log(Tables)	0.225***	5.835	0.245***	6.393				
log(Square Footage)					0.426***	10.067	0.460***	11.257
log(DS_Machines)	-0.568***	-7.947	-0.303***	-5.329				
log(DS_ Tables)	0.170***	2.747	0.097*	1.777				
log(DS_Square Footage)					-0.449***	-13.423	-0.275***	-14.135
log(Population)	-0.366	-0.642	-0.123	-0.216	0.338	0.49	0.452	0.673
log(Per Capita Personal Income)	2.501***	3.821	2.886***	4.415	2.649***	3.394	2.682***	3.503
Unemployment rate	0.011	0.635	0.022	1.269	0.023	1.181	0.022	1.147
Period fixed effects?	Yes		Yes		Yes		Yes	
Property level fixed effects?	Yes		Yes		Yes		Yes	
Observations	486		486		486		486	
R ²	0.975		0.974		0.963		0.964	

* p ≤ 0.10; ** p ≤ 0.05; *** p ≤ 0.01.

present the specifications in which gaming machines and tables are used; columns 3 and 4 present the square footage specifications. The distance-scaled specifications are presented in columns 1 and 3; whereas columns 2 and 4 show the results in which distance-squared scaled competition measures are used.

The gaming machine and table game models (columns 1 and 2) are discussed first. In both specifications, the coefficients on the $\log(\text{Machines})$ and $\log(\text{Tables})$ variables are positive and statistically significant, indicating that an increase in the number of gaming machines or table games at a given casino will increase revenues at that casino. More specifically, using the results in column 1, a 10 percent increase in the number of machines is associated with a roughly 4.5 percent increase in revenues at that casino. The elasticity of casino revenue with respect to gaming tables is approximately half that of gaming machines. That is, a 10 percent increase in the number of table games is explained to increase the casino's revenues by 2.25 percent.

The two distance-scaled competition variables, $DS_Machines$ and DS_Tables , are both found to be statistically significant determinants of casino revenue in both OLS specifications presented in Table 2 (columns 1 and 2). The results in column 1 indicate that a 10 percent increase in distance-scaled machines is estimated to *reduce* revenues at a specific casino by about 5.7 percent, whereas the same percentage increase in distance-scaled tables is estimated to *increase* casino revenue by 1.7 percent. The results in the distance-squared scaled specification are qualitatively similar: An increase in distance-squared scaled machines is estimated to decrease casino revenue, whereas an increase in distance-squared scaled tables is shown to increase casino revenue. These results indicate that consumers view gaming machines at nearby casinos as substitutes for those at a given casino. However, an increased availability of table games, whether it be through a greater number of tables or tables that are located geographically closer to a given casino, can be explained to be weak complementary goods.

The complementary effect of table games may be because gamblers value the option to move to another casino when on a "cold" streak on the table games at a given casino. Machine gamblers, on the contrary, may interpret an extended period of losing on a given machine as increasing the odds that the next pull will reward them with a jackpot. Thus, these gamblers often sit at the same machine (or small group of machines) in the same casino for an extended period of time. Further, given that each casino has many variations of machine games, there is little need to leave the casino for a new experience when such a change is desired by the player.

Alternatively, one can think of the table game result to mean that a *decrease* in table games in one casino leads to lower revenues at competing casinos. Since the trend in Missouri casinos over our sample period has been to reduce casino floor space dedicated to table games, while expanding floor space dedicated to machines, this result here seems consistent with how the casino market has been developing, for example, as found by Levitzky, Assane, and Robinson (2000).

The specifications presented in columns 3 and 4 of Table 2, in which square footage replaces the use of gaming machines and table games, generate similar results as those

discussed earlier. First, an increase in a casino's square footage, *ceteris paribus*, is shown to increase the casino's revenue. More specifically, a 10 percent increase in square footage is estimated to increase that casino's AGR by 4.3 percent, according to the results presented in column 3. The existence of nearer and larger casinos is shown to reduce revenues at any given casino. That is, a 10 percent increase in distance-scaled square footage is estimated to reduce casino revenues by nearly 4.5 percent (column 3). This is consistent with the results discussed earlier with regard to distance-scaled machines, and suggests that the effect of competing machine games dominates the effect of greater regional availability of table games.

To summarize, the results from the OLS model suggest that casinos are sensitive to competing casinos. An increase in a casino's square footage or number of machine games is found to cause a decrease in the revenues at competing casinos. However, a decrease in a casino's table games is found to decrease revenues at competing casinos. Next, the model is used to predict what would happen if a new casino were to be introduced in Missouri.

Predicted Impact of a New Casino

Whether to introduce a new casino was the decision faced by the Missouri Gaming Commission after the President Casino closed in 2010, and it is a decision gaming regulatory agencies across the country will likely face at some time. An interesting extension to the analysis is to consider the model's predicted impact of a new casino being introduced to the Missouri market.

Three possible locations for a new (fictional) casino are considered:

- St Louis (near the intersection of 4th Street and Spruce Street)
- Caruthersville (near the intersection of Truman Boulevard and 3rd Street)
- Cape Girardeau (near the intersection of Broadway Street and Spanish Street Court)

Each of the three locations is depicted in Figure 2 and is denoted by a star. The first two locations are chosen somewhat randomly, solely in order to compute distances to each of the other existing casinos in the state; they are not intended to be realistic proposed sites. Relocating the sites by a few miles will have little influence on the estimated impacts presented below. The Cape Girardeau location, however, is the actual location of the new casino that opened in October 2012. The predicted impact of each fictional casino is considered independently.

For the first two fictional casinos, the size is set as the average size of the existing St. Louis casinos as of the second quarter of 2010, the last period included in the sample. As such, the casino is assumed to be 93,000 square feet with 2,042 gaming machines and 52 table games. For the Cape Girardeau casino, the casino size is that which was approved by the Missouri Gaming Commission for the Isle Casino Cape Girardeau that now operates there: 38,500 square feet, with 1,000 machine games and

TABLE 3. PREDICTED IMPACT OF A NEW CASINO ON EXISTING CASINOS' REVENUES: 2010.2.

Existing casino	Location of new casino		
	St. Louis	Caruthersville	Cape Girardeau
St Jo Frontier	—	—	—
Argosy (KC)	—	—	—
Isle of Capri, KC	—	—	—
Harrah's, N KC	—	—	—
Ameristar, KC	—	—	—
Lady Luck (Caruthersville)	—	-\$3,313,429	\$1,681,404
Harrah's Maryland Heights	-\$404,683	—	—
Ameristar, St Charles	-\$394,637	—	—
President (St. Louis)	-\$151,706	—	-\$1,531

28 table games (Missouri Economic Research and Information Center 2010: 11). There are only two Missouri casinos within 100 miles of the Cape Girardeau casino: the President Casino in St. Louis and the Lady Luck in Caruthersville.¹¹

The influence of the new fictitious casino is, by construction within the model, limited to those casinos within 100 miles. Further, only three of the St. Louis casinos (Harrah's St. Louis, Ameristar St. Charles, and President) are included in our full sample, limiting the measured impact of the new St. Louis casino to those three casinos. There is no other casino in Missouri within 100 miles of the Lady Luck in Caruthersville; thus, the impact of the proposed Caruthersville casino will be limited to the Lady Luck. There are two Missouri casinos within 100 miles of the Cape Girardeau casino (the President, in St. Louis; Lady Luck, in Caruthersville).

Table 3 presents the predicted impact of the three fictional casinos on existing casinos in Missouri. The estimates are based on 2010.2 data and are generated from the results presented in column 1 of Table 2.

The new casino in St. Louis has a predicted negative impact on the three St. Louis casinos' quarterly revenue, averaging about \$316,000 per casino. As the Harrah's and Ameristar properties had revenues between \$70 and \$75 million during that quarter, the new casino is predicted to have very little effect on their revenues. This is likely because those two casinos are about 20 miles away from the fictional new casino. The President Casino, on the contrary, is about 1 mile away from the proposed casino, and the predicted decrease in revenues for that casino is about 3 percent. This predicted impact on the President's revenues is less than expected, but overall these results do suggest that St. Louis is large enough a market to host another casino.

The predicted impact of the Caruthersville and Cape Girardeau casinos are intriguing. The new casino in Caruthersville is predicted to reduce the existing Lady Luck's

revenues by \$3.3 million, or about 40 percent. This large effect is due to the fact that the new casino dramatically changes the distance-scaled competition variables, and suggests that the Caruthersville market is not large enough to support two casinos so close together. The fictional casino in Cape Girardeau is predicted to have a *positive* impact on the Lady Luck in Caruthersville. While this result is surprising, one possible explanation of this effect is that the new casino may help to attract more tourists to the Southeast region of Missouri, and both casinos benefit as a result. (This explanation may not reconcile well with the prediction that another casino in Caruthersville harms the casino already there.) While the primary (distance-scaled) specification does predict a positive impact on Lady Luck, the distance squared-scaled specification from column 2 of Table 2 does suggest a *reduction* in Lady Luck revenues. The primary difference is this result likely stems from the fact that the distance squared-scaled specification discounts more distant competition more heavily than does the distance-scaled specification. The new casino in Cape Girardeau is also predicted to have a very minor, insignificant, impact on the President Casino in St. Louis.

Overall, the estimated impacts of the new casinos in Table 3 based on the OLS specification presented in column 1 of Table 2 are robust to other specifications of the model. For instance, the presented specification predicts a 0.66 percent reduction in existing casino revenue in response to the new St. Louis casino; this impact is reduced to a 0.03 percent reduction based on the distance-squared specification in column 2 of Table 2. The two specifications produce an almost identical predicted change in existing casino revenue in response to a new Caruthersville casino: -2.30 percent versus -2.27 percent. The Cape Girardeau casino results produce a more significant difference. The distance-scaled specification suggests a 1.17 percent increase in existing casino revenue, whereas the distance squared-scaled specification indicates a 0.34 percent reduction. The specifications in columns 3 and 4 of Table 2 also produce estimated revenue impacts similar to those discussed previously.

While the new casinos' predicted impacts are questionable, the analysis here does provide a foundation for future research into the intra-industry relationships among casinos. Despite the predictions above, the OLS model results are robust with respect to the estimation procedure, as discussed in the following section.

Robustness Check: Spatial Durbin Model Estimation

As a robustness check of the OLS two-way fixed effects results discussed in the third section, the model is re-estimated using a spatial Durbin model (SDM) estimation procedure. A growing body of literature suggests that OLS estimates in studies employing cross-sectional or panel data may suffer from spatial dependence; see, for example, LeSage and Dominguez (2012), Lacombe and Shaughnessy (2007), and Hall and Ross (2010). In such circumstances, the coefficient estimates are biased and/or inconsistent, depending on whether the spatial dependence arises in the dependent variable and/or the error term. Various methods of modeling spatial dependence exist, but LeSage and

Pace (2009) argued that the SDM is superior to the spatial autoregressive (SAR) and spatial error model (SEM) for many, if not most, applied situations.¹² The authors present a purely econometric argument for the use of the SDM, that the SDM greatly reduces omitted variable bias when the omitted variable(s) are not only correlated with included independent variables but also vary systematically over space.¹³

The SDM includes both a spatial lag of the dependent variable (Wy) and the spatial lag of the explanatory variables (WX), as described in equation (4):

$$y = \alpha_n + \rho Wy + X\beta + WX\theta + \varepsilon \quad (4)$$

where ε is assumed to be well behaved: $\varepsilon \sim N(0, \sigma^2)$. WX is interpreted as the weighted average of the explanatory variables of neighboring casinos. For example, the spatial lag of the *PCPI* variable is interpreted as the average *PCPI* of the identified neighboring casinos.

The use of a spatial model necessitates the creation of the row standardized spatial weight matrix, W . The two most common methods of determining the spatial weight matrix are: 1) m (often m is chosen as 5 or 10) closest neighbors and 2) those other properties within a specified distance. Given that there are only nine cross-sectional units in the study, the first option is not reasonable. As such, the second option is chosen, but this, too, requires the determination of the appropriate distance. In the current analysis, neighbors are defined as the other Missouri casinos that are within 100 miles.¹⁴

The SDM model is estimated in Matlab, employing LeSage's Spatial Econometrics Library and calling the "sar_panel_FE" function based on Elhorst (2003, 2010). The model is estimated including both period and property-level fixed effects. Interpreting the estimates from any model including Wy on the right-hand side is more complicated than simply looking at the estimated coefficient as was done above in the OLS case. This is because the partial derivative with respect to a given independent variable is an $n \times n$ matrix rather than a scalar (LeSage and Dominguez 2012). In order to interpret such estimation results, one must compute the direct and indirect effects (impacts), a process that is described in LeSage and Pace (2009). The direct effects are interpreted as the own effects—how a given change in an independent variable for a specific casino impacts revenues for that same casino (including all feedback). The indirect effects can be interpreted as the combined spillover effects on all other Missouri casino revenues. The total effects are the sum of the direct and indirect effects.

While the full results—coefficient estimates, direct effects, indirect effects, and total effects—are available in an unpublished appendix (and available from the authors upon request), only the direct effects are presented in Table 4, as these are the results that are most relevant to computing the impact of additional competition on existing Missouri casinos. The LM test results (also available in the unpublished appendix) provide mixed evidence as to whether or not the model suffers from spatial dependence. As such, the SDM model may or may not be econometrically superior to the OLS model.

TABLE 4. SPATIAL DURBIN MODEL WITH PERIOD FIXED EFFECTS RESULTS FOR LOG(CASINO REVENUE): 1997 Q1–2010 Q2.

Variable	[1]		[2]		[3]		[4]	
	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat
log(Machines)	0.481***	7.947	0.435***	7.697				
log(Tables)	0.296***	7.370	0.270***	7.367				
log(Square Footage)					0.537***	10.568	0.518***	9.676
log(DS_Machines)	-0.298***	-4.786	-0.602***	-7.855				
log(DS_Tables)	0.145*	2.229	0.315*	4.162				
log(DS_Square Footage)					-0.227***	-7.794	-0.380***	-7.146
log(Population)	-0.175	-0.183	-0.382	-0.407	0.043	0.041	0.179	0.170
log(Per Capita Pers. Income)	3.114***	4.344	2.854***	4.084	2.501**	3.034	2.453**	2.949
Unemployment rate	0.058*	2.048	0.049*	1.839	0.038	1.138	0.032	0.915

* p ≤ 0.10; ** p ≤ 0.05; *** p ≤ 0.01.

As can be seen in all four columns of Table 4, the SDM results are qualitatively supportive of the OLS results. The scale of a given casino is found to exert a statistically significant impact on the casino's revenue. According to column 1, a 10 percent increase in the number of gaming machines, *ceteris paribus*, at a given casino is affiliated with a roughly 4.8 percent increase in revenues at that casino. Likewise, a 10 percent increase in the number of table games results in an increase in revenues by about 3 percent. If casino scale is instead measured per the square footage (column 3), a 10 percent increase in scale is shown to increase revenues by approximately 5.4 percent. Each of these results is very similar to the OLS results.

The SDM results concerning the impact of scaled competition are also qualitatively similar to the OLS results. A 10 percent increase in distance-scaled gaming machines leads to a 3 percent reduction in competing casino revenues, suggesting consumers treat gaming machines at rival casinos as substitutes. A 10 percent increase in distance-scaled table games is shown, consistent with the OLS results, to increase competing casino revenues by nearly 1.5 percent. Looking at column 3 of Table 4, a 10 percent increase in distance-scaled square footage is associated with a 2.3 percent reduction in competing casino revenues. In total, the relationship between casino revenue and casino scale and scaled competition indicated by the SDM estimation are consistent with those derived from the OLS estimation procedure.

When considering the comparison of the estimated impacts of the three new casinos discussed in the previous section, the results of the SDM are, once again, largely consistent with those presented in Table 3. For instance, the SDM (Table 4, column 1) specification produces a predicted revenue impact similar to that of the OLS distance squared-scaled specification presented in column 2 of Table 2, a 0.03 percent reduction.

Summary and Conclusion

The commercial casino industry is still expanding in the U.S. As the industry becomes more competitive, the industry itself and states considering legalization or the expansion of existing casinos must be concerned with how existing casinos affect each other. There has been little (if any) published research on this issue.

This study tests the impact of competing casinos' sizes and distances on the revenues of a particular casino using quarterly data on Missouri casinos from 1997.1 through 2010.2. A two-way fixed effects OLS model is used, and the robustness of this model is tested with a two-way fixed effects SDM. The results indicate that a casino's revenues decrease as the result of an increase in competing casinos' machine games or square footage, or with a decrease in table games in nearby casinos. These results reflect the fact that casinos in Missouri have recently been shifting floor space away from table games toward machine games. Indeed, slot machines are by far the greatest revenue earners on casino floors in the U.S. When the model is used to predict the impact of a new casino on existing casinos in Missouri, the results generally show that casinos compete with each other. However, the predicted impacts may not be highly

reliable out of sample, as the model was developed to describe existing data rather than for forecasting precision.

It is worth emphasizing that the model only explains revenues for those casinos that existed for the entirety of the sample period, as determined (in part) by competing casinos' sizes and locations. The model does not explain revenues of newly opening or closing casinos. Efforts to add such dynamics into the model would be much more complicated and is beyond the scope of this project. Such an exercise would be an interesting extension to this analysis.

Although the analysis indicates that casinos in the same market do compete with each other, the addition of a new casino in Missouri will still lead to a large increase in state-level casino revenues, as the predicted "substitution effect" across casinos is relatively small. There is no evidence, based on the Missouri data and analysis, that there is a positive agglomeration impact from clustered casinos. However, future research should examine whether such an effect does exist, in markets such as Las Vegas, Atlantic City, and Biloxi, where tourists may be attracted to the area because of the variety of casinos available. This study could serve as a foundation for such analyses, as well as analyses similar to this applied to other casino markets. Another potentially fruitful extension of this analysis would be to test whether the casino industry is reaching some type of "saturation point" in the U.S.

NOTES

1. There was a decline in revenues during the recession of 2007–2009, but nationally revenues have been increasing since 2009.
2. For more on the evolution of regulations, see the Missouri Gaming Commission website, <http://mgc.dps.mo.gov/>.
3. Thalheimer and Ali (2003) estimated that only 4 percent of visitors come from more than 100 miles away from a casino. This estimate is based on 1997 Illinois data. Since there has been significant expansion of casinos since then, it is unlikely that Tunica would impact any Missouri casinos.
4. One referee suggested that the model should be run using per capita casino revenues as a dependent variable. This was done, and the results are not markedly different from those presented. It is acknowledged that the analysis could also be done using number of casino patrons, rather than revenues. The main reason to use revenues is that, as a matter of policy, politicians and voters are more concerned with the tax revenues raised by casinos, and not by the number of customers. Although the state does charge an admission tax, the great majority of its revenues from casinos come from the tax on gross gaming revenues. Using revenues seems to be the most direct way to examine the relationships among casinos.
5. Several casino closings were reported, usually due to flooding. These closures lasted an average of about two weeks. However, given the data are quarterly revenues, the closings are relatively minor and are not accounted for in the analysis.
6. Non-Missouri casino revenue data are not included on the left-hand side of the model. This is because the focus here is on the Missouri casino market in particular. Also, several of the casinos outside Missouri are tribal casinos, and revenue data are not available for those.
7. See www.igb.illinois.gov. Reports are not available prior to 1999. However, the Public Information Officer of the Illinois Gaming Board indicated that there were no significant changes to the three casinos in the 100-mile competition threshold from their openings through 1998. For 1997, 1998 values are used, which were reported in the 1999 annual report.

8. An additional factor that was tested, but is not included in the model presented here, is the smoking ban that was implemented in Illinois on January 1, 2008. When a smoking ban dummy variable is included for the St. Louis casinos that would most likely be affected, the impact of the Illinois smoking ban on the Missouri casinos was *negative*. This unlikely result probably indicates that the dummy is picking up something else happening in St. Louis. Or, the negative Illinois smoking ban effect could be possible if the traffic of non-smoking Missourians going to Illinois casinos was greater than the traffic of Illinois smokers coming to Missouri casinos. This is unlikely, but it is worthy of further investigation. In any case, the smoking ban variable did not markedly affect any other coefficient estimates in the model.
9. One reader of the paper suggested that the distance from the casinos to the relevant population center be used to model casino demand, rather than using the distance between casinos. This would seem to help explain a particular casino's revenues, as most of the casinos' revenues likely come from nearby customers. However, in order to model the casino market in this way, one must assume that the population exists at one particular point in the casino market. Since the casinos in St. Louis and Kansas City are fairly close to each other, this type of model would not be expected to provide particularly interesting or meaningful results. Furthermore, a recent study has shown that most people do not visit the closest venue most of the time, although machine gamblers do so more than non-machine gamblers (Young, Markham, and Doran 2012). This evidence suggests that using the population centroid as the main determinant of demand may be inappropriate.
10. 2010 estimates for some regions are based on the prior two years' average rates of change.
11. Recall that the President Casino is now closed, but it was open during the entire sample period. The results are still informative, as they can be interpreted as the impacts on a casino similar to the President in the St. Louis market.
12. This argument is further emphasized in LeSage and Dominguez (2012). Also see McMillen (2010) for a discussion of spatial modeling.
13. In this case, such an omitted variable could include, among others, immeasurable social norms and preferences regarding gambling, which are not fully captured by per capita personal income and the unemployment rate.
14. No other Missouri casino is within 100 miles of Lady Luck in Caruthersville; however, the spatial econometric model requires that each cross section have at least one neighbor. As such, the closest Missouri casino, the President Casino, is assumed to be the sole neighbor of Lady Luck.

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