URBAN LOCATION AND THE SUCCESS OF CASINOS IN FIVE STATES

Thomas E. Lambert, Indiana University Southeast
Arun Kumar Srinivasan, Indiana University Southeast
Uric B. Dufrene, Indiana University Southeast
Hokey Min, Bowling Green State University

ABSTRACT

Over the last 30 years or so, many states in the US have legalized casino gambling/gaming in an effort to boost tax revenues. Four mid-western (Illinois, Indiana, Iowa, and Missouri) and two southern (Louisiana and Mississippi) states adopted legalized gaming in the form of riverboat casinos due to legal restrictions originally against land-based casinos. Following changes in state laws, land-based casinos and racinos (a combination of a casino and a racetrack) have since appeared in these states, although riverboat casinos still compose the majority of the establishments in most of these states. Although the scholarly literature is replete with articles on whether casinos make a difference in state tax revenues or cause an increase in crime, bankruptcies or other negative externalities, few if any have been written about the efficiency and effectiveness of casino operations and what external factors (location, size of market, etc.) are important to casino success. With so many states relying on casino revenues and others recently enacting or trying to permit casino gaming, it would be desirable to know those factors which influence casino success. Tax dollars often hinge on the type of casino permitted and related location decisions. Hence, such decisions have public policy implications, and this article is the first to pinpoint factors that determine casino success.

JEL: R11; R12

KEY WORDS*:* Casinos, data envelopment analysis, gaming and gambling, urban economics

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INTRODUCTION

It is well known in the retailing and urban economics literature that location is a crucial variable in a business enterprise's success or failure. Especially important is the ease of access that customers have to a firm's products or services and how much time they have to make in their journey to the site, whether within a small city or large metro area (O'Sullivan, Chapter 5, 2003). Whether location has an impact on a casino's efficiency in operations and success is explored in this paper. First, a literature review discusses what has been written previously about casinos with regard to their proliferation and success in generating state tax revenues. Next, a methods section discusses which variables are important to the analysis and how data from various casinos are to be analyzed. Then, in a results section, the findings of the analysis are elaborated, which is followed by a discussion of the results long with concluding remarks that have some public policy recommendations.

LITERATURE REVIEW

Starting in the late 1970s, more than two dozen state governments in the US enacted laws permitting legalized casino gambling, racinos (a combination of a casino and race track), state lotteries, electronic gaming devices at bars and entertainment centers, and tribal casinos. The increased presence of various forms of gambling comes in reaction to more tolerant attitudes toward gambling, the need to raise more tax revenues, and economic development objectives (Madhusudhan 1996, Eadington 1999, Garrett 2003, and Landers 2009). This expansion of gambling occurred in spite of fears about increased crime rates and personal bankruptcies (Friedman, Hakim, and Weinblatt, 1989; Garrett and Nichols, 2008; Hsu 2000; Stitt, Nichols, and Giacopassi, 2003; Koo, Rosentraub, and Horn, 2007) and the cannibalization by casinos of other local hospitality and entertainment venues so that the net impact of a casino could be muted (Guell, 2010).

During the current US recession which began in late 2007, several states are now exploring the casino gambling option, motivated by falling state revenues and the need for economic development. As Guell (2010) points out, casinos generate around $5 billion annually in tax receipts for state and local jurisdictions on approximately $30 billion in casino revenues. He notes that casinos have only a slight impact on employment in communities with high unemployment prior to the casino opening, whereas Garrett (2003) notes that casinos have their biggest employment affects in rural areas. Ohio voters recently approved casino gambling in a November 2009 referendum as elected officials in Kentucky continued to debate the approval and enactment of gaming proposals (Hall, 2009; Simon, 2009).

Despite the research on the overall economic and social impacts of casinos, especially on their contributions to state coffers and local economic development, no research has been done on what makes a specific casino efficient and effective in attracting patrons and generating revenues (so that state and local governments can collect more money) or on the local and regional circumstances that influence such casino efficiency and success. From a state and local perspective, such information would support decisions on casino licensing, taxation and other policy issues. Whether casino location and market population size have an impact on casino success, or whether racinos do better on average than regular casinos, all would be useful considerations for policy purposes.

METHODS

For purposes of making valid comparisons, this paper examines the operations of casinos in five states (Illinois, Indiana, Iowa, Louisiana, and Missouri) which legalized casinos in the late 1980s or early 1990s and allowed only riverboat casinos (whether docked or not docked) in the early stages of development. Even though five now permit land based casinos and three (Indiana, Iowa, and Louisiana) permit racinos, riverboat casinos constitute the majority of the casino establishments. Mississippi, a riverboat and casino gambling state, would be on our list of states, but the Mississippi Gaming Commission does not provide casino revenues on a per boat basis, only on a total regional basis (http://www.mgc.state.ms.us/). Therefore, Mississippi is not included in the analysis.

Interestingly the gaming commissions' websites or annual reports for each state list most if not all of the other 5 states with riverboat casinos for purposes of comparison (Annual Reports 2008 and 2009). Although riverboat casinos were permitted initially because they satisfied legal requirements of no gambling on land, they also easily satisfied the desire of these states to "export" gambling entertainment to neighboring communities in other states, some of which did not permit any casino gambling (Eadington, 1999; Guell, 2010).

Tribal casinos, which also gained popularity and grew rapidly in the 1980s and 1990s, are not considered in this paper. None is present in Illinois, Indiana, or Missouri. Only one out of 16 casinos exists in Louisiana and only 3 out of 16 exist in Iowa (Wenz, 2008). Operating data for tribal casinos are also usually not disclosed and therefore not susceptible to substantive analysis.

Because gaming in the five states is so similar (riverboat casinos and the presence of racinos), benchmarking the performance of the casinos in the five states lends itself well to the data envelopment analysis (DEA) technique. In general, DEA is a linear programming (non-parametric) technique that converts multiple inputs and outputs of each decision-making unit from a list of decision-making units (DMUs) into a scalar measure of operational efficiency, relative to its competing DMUs. DMUs can be a collection of private firms, non-profit organizations, governmental departments, administrative units, and other groups with the same (or similar) goals, functions, standards, and/or market segments. DEA can be employed for measuring the comparative efficiency of any entity which has inputs and outputs and is similar to peer entities in an analysis. Therefore, DEA can be applied to a wide variety of DMUs including similar casinos in different states.

For the inputs and outputs used in the DEA, see Table 1. These were chosen because the most recent annual reports (2008) for all five states had these variables in common. Some states' annual reports gave the number of eating establishments, conference rooms, hotel rooms, and number of golf courses at each casino whereas others did not. So these aspects of casinos were omitted as inputs. There is also no data on promotion expenses or what entertainment is provided, so these factors were also ignored as inputs. It would have been desirable to know the portion of casino patrons originating from other states (the "export" effect), but only Louisiana gives these estimates. Nevertheless, the input variables in Table 1, the number of employees, gaming devices, gaming tables, square footage of space per establishment, and the presence of a racetrack, are all key input variables to the success of a casino.

For outputs, the analysis focuses on two key important variables: the number of customers attending in 2008 and the amount of revenues earned in 2008. The admissions variable is chosen because of the impact of customers on casino earnings, and the influence on tourism and potential economic development. Total revenues generated are an obvious choice because tax revenues depend upon casino revenues.

Table 1: Descriptive Statistics

Variables	Mean	Standard Deviation
Inputs		
Employees	919.3	535.08
Gaming Space (sq.ft.)	41,900.5	27,759.9
Electronic Gaming Devices	1312.1	562.08
Table Games		
Race Track		
Outputs		
Admissions	2,284,210	1,793,974
Total Revenue($)	120,046,381	106,340,170
CRS Efficiency Index	0.72	0.21
VRS Efficiency Index	0.84	0.14
Environmental Factors		
Economies of Urbanization and Agglomeration (Index)	0	1.0
Average of Average January and Average July Temperature	54.3	7.75
Annual Precipitation (Inches)	0.84	0.14
Border Effect (1=Yes, 0=No)	0.82	0.39
N	66	

This table reports the means and standard deviations for the variables used in the data envelopment analysis (inputs and outputs) as well as those used in the Tobit regression (the dependent variables, which are the CRS and VRS efficiency indices, and the independent variables, which are the environmental factors).

DEA is designed to identify the "best practices" DMU without a priori knowledge of the inputs. Outputs are most important in determining an efficiency score and assessing the extent of inefficiency for all other DMUs that are not regarded as the best practices DMUs (Charnes et al., 1978). Since DEA provides a relative measure, it differentiates between inefficient and efficient DMUs relative to each other. Owing to its capability to pinpoint inefficient DMUs from efficient DMUs, DEA can be useful for developing benchmark standards (Min et al., 2008).

The DEA model can be mathematically expressed as (Charnes et al., 1978; Fare et al., 1994; Nolan et al., 2001):

$$\text{Maximize efficiency score } (jp) = \frac{\sum_{r=1}^{t} u_r y_{rjp}}{\sum_{i=1}^{m} v_i x_{ijp}} \quad (1)$$

$$\text{Subject to } \quad \frac{\sum_{r=1}^{t} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1, \quad j = 1, \ldots, n, \quad (2)$$

$$u_r, v_i \geq \varepsilon, \qquad \forall r \text{ and } i, \quad (3)$$

where

y_{rj} = amount of output r produced by DMU j,

x_{ij} = amount of input i used by DMU j,

u_r = the weight given to output r,

v_i = the weight given to input i,

n = the number of DMUs,

t = the number of outputs,

m = the number of inputs,

ε = a small positive number.

To ease computational complexity associated with the fractional nonlinear form of the above equations, the above equations (1), (2), and (3) can be converted into a linear program as follows.

$$\text{Maximize efficiency score } (jp) = \sum_{r=1}^{t} u_r y_{rjp} \quad (4)$$

$$\text{Subject to } \sum_{i=1}^{m} v_i x_{ijp} = a, \quad (5)$$

$$\sum_{r=1}^{t} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0, \qquad j=1,\ldots,n, \quad (6)$$

$$-u_r \leq -\varepsilon, \qquad r=1,\ldots,t, \quad (7)$$

$$-v_i \leq -\varepsilon, \qquad i=1,\ldots,m, \quad (8)$$

where a = an arbitrarily set constant (e.g., 100)

By solving the above equations (4)-(8), the efficiency of DMU (jp) is maximized subject to the efficiencies of all DMUs in the set with an upper bound of 1 (Lambert, Min and Srinivasan, 2009; Min and Lambert, 2006). The above model is solved n times to evaluate the relative efficiency of each DMU. Notice that the weights u_r and v_i are treated as unknown variables whose values will be optimally determined by maximizing the efficiency of the targeted DMU jp. An efficiency score (jp) of 1 indicates that the DMU under consideration is efficient relative to other DMUs, while an efficiency score of less than 1 indicates the DMU under consideration is inefficient. In a broader sense, an efficiency score represents a casino's ability to transform a set of inputs (given resources) into a set of outputs. The above model also identifies a peer group (efficient DMU with the same weights) for the inefficient DMU (Anderson, *et al*, 1999; Boussofiane, *et al*, 1991).

In this paper, the conservative assumption that casinos operate with constant returns to scale (CRS) efficiency (inputs are matched in fixed proportions) is made since scores based on variable returns to scale (VRS) efficiency tend to raise or inflate the scores (Garcia-Sanchez, 2006), although the results of analyzing VRS efficiency are briefly discussed. A casino is operating as efficiently as possible as it tries to maximize the outputs, admissions and revenues, while minimizing its inputs such as number of employees, number of gaming devices, number of gaming tables, square footage of gaming space, etc. Again, a score of 1.0 indicates efficiency, and anything less represents inefficiency. Table 2 shows DEA scores (CRS and VRS efficiency scores) that were calculated by using values for these inputs and outputs for 66 different casinos in the five states.

Table 2: Efficiency Scores for Casinos in Five States

Decision Making Unit Name	VRS Efficiency	CRS Efficiency
Ameristar East Chicago, E. Chicago, IN	0.84081	0.80532
Argosy, Lawrenceburg, IN	1.00000	0.82273
Belterra, Vevay, IN	0.62032	0.57500
Blue Chip, Michigan City, IN	0.72024	0.70693
Casino Aztar, Evansville, IN	0.64711	0.48133
French Lick Casino, French Lick IN	0.56925	0.44031
Grand Victoria, Rising Sun, IN	0.62279	0.58964
Hoosier Park, Racino, Anderson, IN	1.00000	1.00000
Horsehoe Hammond, Hammond, IN	1.00000	0.99188
Horseshoe Southern Indiana, Elizabeth, IN	0.77223	0.76691
Majestic Star I, Gary, IN	0.61083	0.50508
Majestic Star II, Gary, IN	0.88161	0.82535
Prairie Meadows Racino, Altoona, IA	0.56624	0.54508
Horseshoe Casino and Bluffs Run Greyhound Park, Council Bluffs, IA	0.78240	0.76555
Dubuque Greyhound Park and Casino, Dubuque, IA	0.73126	0.64251
Lady Luck Casino, Marquette, IA	0.97769	0.44367
Diamond Jo, Dubuque IA	0.62062	0.47175
Wild Rose, Clinton, IA	0.92389	0.54216
Catfish Bend Casino, Burlington, IA	1.00000	0.75993
Argosy, Sioux City, IA	0.89266	0.70765
Terrible's Lakeside Casino, Osceola, IA	0.69606	0.50417
Wild Rose, Emmetsburg, IA	1.00000	0.42928
The Isle Casino & Hotel, Waterloo, IA	0.67983	0.59607
Rhythm City, Davenport, IA	0.96601	0.76229
Isle of Capri, Bettendorf, IA	0.68863	0.58284
Ameristar II, Council Bluffs, IA	0.72426	0.67083
Harrah's Council Bluffs Casino & Hotel, Council Bluffs, IA	0.72787	0.57800
Diamond Jo, Northwood, IA	0.81028	0.72334
Riverside Casino & Golf Resort, Riverside, IA	0.76117	0.67680
Argosy Casino, Alton, IL	0.85396	0.62080
Par-A-Dice Gaming Corp, East Peoria, IL	0.79799	0.60488
Rock Island Boatworks, Rock Island, IL	0.72938	0.36820
Empress Casino, Joliet, IL	0.75684	0.70007
Southern Illinois Riverboat Casino/Cruises, Metropolis, IL	0.74394	0.65414
Harrah's Casino Cruises, Joliet, IL	1.00000	1.00000
Hollywood Casino, Aurora, IL	0.92883	0.89297
Casino Queen, East St Louis, IL	0.84095	0.77918
Grand Victoria Elgin Riverboat Resort, Elgin, IL	1.00000	1.00000
Ameristar Casino, Kansas City, MO	0.95688	0.84922
President Casino, St Louis, MO	1.00000	1.00000
Ameristar Casino, St Charles, MO	1.00000	0.98911
Argosy Riverside Casino, Riverside, MO	1.00000	1.00000
Terrible's St Jo Frontier Casino, St Joseph, MO	1.00000	0.92625
Harrah's North Kansas City, Kansas City, MO	0.96562	0.95468
Lady Luck of Caruthersville, Caruthersville, MO	0.89715	0.55477
Isle of Capri, Kansas City, MO	1.00000	1.00000
Harrah's Maryland Heights, Maryland Hts., MO	0.95355	0.94457
Isle of Capri, Booneville, Booneville, MO	1.00000	0.92366
Terrible's Mark Twain Casino, Lagrange, MO	1.00000	0.86910
Lumiere's Place, St Louis, MO	1.00000	1.00000
Catfish Queen, Baton Rouge, LA	0.61932	0.45602
Belle of Orleans, Amelia, LA	0.63016	0.04332
Isle of Capri, Westlake, LA	1.00000	1.00000
Eldorado Casino Resort, Shreveport, LA	0.87893	0.81234
Horseshoe Casino — Bossier City, LA	0.79831	0.62211

Decision Making Unit Name	VRS Efficiency	CRS Efficiency
Hollywood Casino, Baton Rouge, LA	0.68429	0.51051
Diamond Jacks, Bossier City, LA	0.72877	0.60616
Boomtown, Bossier City, LA	0.75739	0.55628
Boomtown, Harvey, LA	0.82998	0.75190
Lau barge Du Lac, Lake Charles, LA	1.00000	1.00000
Sam's Town, Shreveport, LA	0.76778	0.69355
Isle of Capri, Westlake, LA	0.80346	0.34130
Treasure Chest, Kenner, LA	0.75303	0.45346
Delta Downs, Vinton, LA	1.00000	1.00000
Harrah's LA Downs, Shreveport, LA	1.00000	0.91359
Evangeline Downs, Lafayette, LA	1.00000	1.00000

VRS Efficiency: Variable returns to scale efficiency. CRS Efficiency: Constant returns to scale efficiency. This table gives VRS and CRS efficiency scores based on the inputs and outputs listed in Table 1 using data envelopment analysis.

These scores then were regressed against a set of independent (environmental) variables using Tobit regression which expresses observed responses in terms of latent variables. In general, Tobit regression is intended for analyzing continuous data that are censored, or bounded at a limiting value. The Tobit regression model is well suited to measure the transformed efficiency such as DEA efficiency scores, when dependent variables have sensible partial effects over a wide range of independent variables (Amemiya, 1985; Breen, 1996; Wooldridge, 2006). A Tobit regression model assumes that the dependent variable has its value clustered at a limiting value, usually zero. However, in our model, the dependent variable is limited from above (right censored at 1.0), and the model can be written in terms of the underlying or the latent variable as:

$$y_i^* = X_i \beta + \varepsilon_i \tag{9}$$

where $\varepsilon_i \sim N(0,\sigma^2)$. In our sample, we observe y (=y*) only, when $y_i^* < c$ (right censored). The values of Y are censored to the right at 1, and thus we need to estimate

$$E(y_i \mid y_i < c, x_i) = E(y_i \mid \varepsilon_i \le c - x_i \beta_i) \tag{10}$$

The probability that $\varepsilon_i \le c$ is

$$\Phi\left[\frac{c}{\sigma}\right] = \int_{-\infty}^{c/\sigma} \frac{1}{\sqrt{2\pi}} \exp(-t^2/2)dt \tag{11}$$

The expected value is

$$E(y_i \mid y_i < c, x_i) = x_i^{'}\beta - \sigma \frac{\phi(c)}{\Phi(c)} \tag{12}$$

$$= x_i^{'}\beta - \sigma\hat{\lambda}_i(c), \text{ where } c = \frac{c - x_i^{'}\beta}{\sigma} \tag{13}$$

Thus, the Tobit model accounts for truncation of the dependent variable value. A regression of the observed "y" values on "x" will lead to an unbiased estimate of b (or the coefficient of the independent variable(s)). he independent variables used in both the Tobit and OLS regression models are:

1. Urban Economics Index (Urban Econ): This variable is an index created from factor analysis (see Table 3) and represents many of the effects of economies of agglomeration (clustering of similar firms, occupations, and people) and economies of urbanization (population threshold effects necessary for

certain activities) present in an urban marketplace. Creating an index of different variables that make up these effects also avoids multicollinearity among these variables if one were to try to use these variables as different independent variables in regression models. Additionally, there are some variables, which although not part of economies of agglomeration or economies of urbanization, are highly correlated with these effects and are brought up in the literature on casinos, such as unemployment rates, per capita income, and inequality (estimated Gini coefficient for the area), and these are included in the Urban Economics Index. An attempt to create two indices, one focusing on urban size variables (population, population density, etc.) and another focusing on socioeconomic variables (unemployment, education, etc.) was tried. Unfortunately, both these indices were highly correlated (r=0.837). Therefore, the Urban Economics Index was developed to capture both effects. As mentioned earlier, casinos are often used for economic development and to employ slack resources in many areas, although some point out that casinos bring with them higher crime rates, greater poverty and unemployment and that they tend to pray upon the most vulnerable of society. At the same time, casinos are claimed to do best in areas with higher per capita income and in areas with large percentages of high-income households and college graduates (Huebsch, 1997; Pfaffenberg and Costello, 2002). Therefore, estimates of an area's 2008 unemployment rate (US Bureau of Labor Statistics, 2008), its per capita income for 2008 (US Census Bureau, 2008), its 2006 Gini Coefficient (Census Bureau), its percentage of college educated adults (Census Bureau, 2008), and its percentage of households with income of $150,000 per year or more (Census Bureau, 2006) are used as part of the Urban Economics Index as these variables are highly correlated with one another and with metro area population and size effects. Table 4 shows the degree of correlation among different variables used and considered in this paper.

Table 3: Results of Factor Analysis - Urban Economics Index, Principal Component Factor Analysis of the Correlation Matrix, & Un-rotated Factor Loadings and Communalities.

Variables	Factor	Communality
Unemployment Rate 2008	0.436	0.190
Per Capita Income 2008	0.813	0.661
Percent Household Income -$150000 and above, 2006	0.934	0.872
Educational Attainment - Percent Bachelor degree or more, 2008	0.770	0.593
Gini Coefficient 2006, Estimate	0.423	0.179
Population 2008 (millions)	0.848	0.719
Amusement, Gambling and Recreation Establishments	0.858	0.736
MSA Presence (Yes = 1, No=0)	0.614	0.377
Admissions	0.472	0.223
Density Index of Home County	0.638	0.407
Variance	4.957	4.957
% Variance	0.496	0.496
Factor Score Coefficients		
Unemployment Rate 2008	0.088	
Per Capita Income 2008	0.164	
Percent Household Income -$150000 and above, 2006	0.188	
Educational Attainment - Percent Bachelor degree or more, 2008	0.155	
Gini Coefficient 2006, Estimate	0.085	
Population 2008 (millions)	0.171	
Amusement, Gambling and Recreation Establishments	0.173	
MSA Presence (Yes = 1, No=0)	0.124	

These are the variables used to construct the index Urban Economics Index with their factor loadings and communalities, which show the strength of correlation among the variables.

Table 4: Correlation Coefficients Matrix

	X1	X2	X3	X4	X5	X6	X7	X8	X9
VRS Efficiency	1.00								
CRS Efficiency	0.76	1.00							
Unemp. Rate	0.13	0.26	1.00						
Poverty	-0.14	-0.15	0.08	1.00					
Population	0.16	0.33	0.44	-0.18	1.00				
Amusement est.	0.18	0.33	0.42	-0.16	0.99	1.00			
Amusement per capita	0.09	-0.14	-0.13	0.39	-0.43	-0.38	1.00		
Per capita income	-0.01	0.18	0.12	-0.12	0.65	0.66	-0.42	1.00	
Income $150,000+	0.10	0.36	0.29	-0.06	0.81	0.81	-0.52	0.77	1.00
Educational Level	0.02	0.31	0.06	-0.22	0.53	0.54	-0.57	0.69	0.80
Admissions	0.38	0.58	0.31	-0.11	0.20	0.21	-0.22	0.25	0.31
MSA Presence	0.10	0.35	0.04	0.18	0.26	0.30	-0.09	0.55	0.52
Admissions/Population	0.17	0.10	-0.09	0.15	-0.39	-0.38	0.73	-0.50	-0.50
Density Index	0.25	0.41	0.34	-0.10	0.40	0.41	-0.35	0.42	0.49
Pct. income $150,000+	0.10	0.36	0.29	-0.06	0.81	0.81	-0.52	0.77	1.00
Gini Coefficient	-0.03	0.17	0.45	0.69	0.26	0.28	0.24	0.18	0.38
Avg. Daily Temp. Jan.	-0.02	-0.06	0.17	0.80	-0.32	-0.28	0.51	-0.12	-0.11
Avg. Daily Temp. July	0.07	0.00	0.12	0.63	-0.44	-0.39	0.43	-0.18	-0.20
Annual Precipitation	-0.13	-0.17	0.15	0.80	-0.26	-0.23	0.51	-0.11	-0.10
Border Effect	0.30	0.33	0.33	-0.17	0.22	0.27	0.26	0.08	0.02

Table 4-Continueed	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20
Education Levels	1.00										
Admissions	0.34	1.00									
MSA Presence	0.56	0.32	1.00								
Admissions/Population	-0.56	-0.03	-0.24	1.00							
Density Index of Co.	0.38	0.62	0.37	-0.32	1.00						
Pct. Income $150,000+	0.80	0.31	0.52	-0.50	0.49	1.00					
Gini Coefficient	0.11	0.12	0.44	0.08	0.18	0.38	1.00				
Avg. Daily Temp Jan.	-0.35	0.04	0.19	0.32	0.01	-0.11	0.65	1.00			
Avg. Daily Temp July	-0.28	0.19	0.19	0.25	0.13	-0.20	0.41	0.87	1.00		
Annual Precipitation	-0.37	-0.08	0.11	0.33	-0.02	-0.10	0.68	0.95	0.72	1.00	
Border Effect	-0.05	0.21	0.16	0.13	0.07	0.02	0.04	-0.04	0.00	-0.13	1.00

This table indicates correlation between the listed variables. X1: VRS efficiency, X2: CRS efficiency, X3: Unemployment rate 2008, X4: Poverty rate 2006, X5: Population 2008 (millions), X6: Amusement, gambling and recreation (NAICS 713) establishments in area of size 500+ in 2007, X7: Amusement, gambling, etc per million population, X8: Per capital income 2009, X9:Percent household with income $150000 or more in 2006, X10: Education attainment – Bachelor Degrees and above in 2008, X11: Admissions, X12: MSA Presence (Yes = 1, No =0), X13, Admissions/Population (millions); X14, Density index of home county, X15: Percent household with income $150,000 or more in 2006, X16: Gini coefficient 2006 estimate, X17: Average Daily Temperature in January, X18: Average Daily Temperature in July, X19: Annual Precipitation in Inches, and X20: Border Effect (1=Yes, 0 =No).

One important hypothesis is that metropolitan or urban size and built environment characteristics are key variables in determining casino success since casino admissions are likely contingent on the market size of the casino's location and ease of access by patrons. For this reason, the Census Bureau's 2008 estimate of the metro, micropolitan, or county's (if the casino is not in a metro or micro area) population in millions is used along with each casino's admissions numbers for 2008 (used as an external demand variable here, not as a supply variable when used in the DEA calculations) in the Urban Economics Index variable. Additionally, the population and housing densities of the casino's home county are deemed important because higher population and housing densities signify a higher degree of infrastructure and roadway connectivity than that which exists in lesser-developed ex-urban and semi-rural areas (Lambert and Meyer, 2006, 2008). These densities make access easier for casino patrons, who should help raise a casino's attendance, everything else held constant. The estimated population and housing densities per square mile for 2008 (Census Bureau) are combined into a density index in order to assess the extent of development in the home county of the casino. Such an index has been employed in other articles as a way to distinguish between urban and ex-urban areas (Lambert and Meyer, 2006, 2008) and is used here as part of the Urban Economics Index.

The number of firms classified as "Amusement, Gambling and Recreation Establishments" according to the US Census Bureau's 2007 County Business Patterns is used as an indication of the degree of competition for each casino as well as agglomeration economies present in each area (casinos and gambling establishments tend to cluster together). It is expected that with greater competition, a casino should be more efficient, everything else held constant, and that a casino will have greater access to a common labor pool trained in casino and entertainment operations (an economies of agglomeration effect).

Finally, whether the casino is located in a MSA or not (1=Yes, 0=No) is used as part of the Urban Economics Index to distinguish MSA markets from micropolitan area markets and non-metro and non-micro markets. These distinctions take into account population size effects as well as built environment effects. The hypothesis is that metro area casinos do better than non-metro area casinos, and the Census Bureau's list of US metro and micro areas and their component counties is used (2008). Some of the casinos in the states chosen for analysis are neither in metro or micropolitan areas.

2. Average of the Average Temperatures of January and July, 1971-2000 (Avg of Avg Temp): The average of the average daily temperatures for each area during the months of January and July are calculated and used to assess the degree of year round warm weather. The hypothesis is that warmer weather on average generates greater attendance, and hence, greater casino success. This is especially true when dog or horseracing is present alongside casino operations since these events are normally held in warmer rather than colder months. Colder weather also usually implies snow during the winter months, which may inhibit casino attendance. (Source: US Census Bureau, *County and City Data Book, 2007*).

3. Average Annual Precipitation in Inches, 1971-2000 (Annual Prec in Inches): This variable is used to measure the expected annual amount of snowfall and rainfall for the city in which each casino is located. Large amounts of precipitation could impinge upon casino or track attendance and casino efficiency, and the hypothesis is that the greater the value of this variable, the lower the efficiency score. (Source: US Census Bureau, *County and City Data Book, 2007*).

4. Border Effect (1=Yes, 0=No): Since the literature points out that casinos are often located on state borders in order to "export" casino revenues and taxes to residents of other states and to maximize attendance, this variable is used to test the hypothesis of whether border effects are key to casino efficiency and success. Unfortunately, only Louisiana gives estimates of what portion of casino patrons come from other states. So only geographic location can be used to assess the successfulness of border locations. Therefore, a casino in a county that is on a border between two states is hypothesized to be more efficient than one that is not, everything else held constant.

RESULTS

Using the independent variables listed and defined above, the following regression model was estimated for both indices (CRS and VRS) in both Tobit and Ordinary Least Squares (OLS) form:

$$\text{CRS/VRS Efficiency Index} = \alpha + \beta_1(\text{Urban Economics Index}) + \beta_2(\text{Average of Average Temperatures}) + \beta_3(\text{Annual Precipitation}) + \beta_4(\text{Border Effect}) \quad (14)$$

The results for the CRS Efficiency Index and the VRS Efficiency Index are shown in Tables 5 and 6 respectively.

Table 5: Regression, CRS Efficiency is Dependent Variable.

Independent Variables	Tobit Model	Ordinary Least Square Model
Urban Economics Index	0.1021***	0.0891**
	(0.026)	(0.023)
Average of Average Temperatures	0.0210**	0.0175***
	(0.008)	(0.007)
Annual Precipitation (in inches)	-0.0164**	-0.0141**
	(0.006)	(0.006)
Border Effect (1=Yes, 0=No)	0.1021	0.1060
	(0.068)	(0.060)
Intercept	0.2024	0.2823
	(0.237)	(0.207)
Log-Likelihood Ratio	-1.254	
Adj-r^2		0.294
N	66	66

This table shows the Tobit and OLS regression estimates of the equation: CRS Efficiency Index = α + β_1(Urban Economics Index) + β_2(Average of Average Temperatures) + β_3(Annual Precipitation) + β_4(Border Effect). Urban Economics Index is an index of different variables comprising economies of agglomeration and urbanization; Average of Average Temperatures is the average of the average temperatures of January and July for each metro area; Annual Precipitation is an average of precipitation amounts for each metro area; and Border Effect is whether the casino/racino is located in a county on the border with another state.
**** and ** indicate significance at the 1 and 5 percent levels respectively, and figures in parentheses are standard errors.*

Table 6: Regression, VRS Efficiency is Dependent Variable

Independent Variables	Tobit Model	Ordinary Least Squares Model
Urban Economics Index	0.0279	0.0188
	(0.023)	(0.017)
Average of Average Temperatures	0.0183*	0.0122*
	(0.008)	(0.005)
Annual Precipitation (in inches)	-0.0140*	-0.0096*
	(0.006)	(0.004)
Border Effect (1=Yes, 0=No)	0.0795	0.0774
	(0.059)	(0.044)
Intercept	0.4087	0.5240
	(0.208)	(0.153)
Log-Likelihood Ratio	-2.402	
Adj-r^2		0.125
N	66	66

This table shows the Tobit and OLS regression estimates of the equation: VRS Efficiency Index = α + β_1(Urban Economics Index) + β_2(Average of Average Temperatures) + β_3(Annual Precipitation) + β_4(Border Effect). Urban Economics Index is an index of different variables comprising economies of agglomeration and urbanization; Average of Average Temperatures is the average of the average temperatures of January and July for each metro area; Annual Precipitation is an average of precipitation amounts for each metro area; and Border Effect is whether the casino/racino is located in a county on the border with another state.
**** and ** indicate significance at the 1 and 5 percent levels respectively, and figures in parentheses are standard errors.*

Table 5 shows the Tobit and OLS regression results when CRS efficiency is used as the dependent variable. Neither model has a large degree of explanation of variance, yet that is sometimes the case when explaining DEA results. Often a high explanation of variance is a pseudo r-square of 50% (Garcia-Sanchez 2006; Lambert, Min, and Srinivasan, 2009; Moore and Segal, 2005; Nolan, Ritchie, and Rowcroft, 2001). The results of the two models are very similar with the variables Urban Econ, Avg of Avg Temp, and Annual Prec all showing statistical significance with p-values less than 0.05 and having the hypothesized signs expected. Larger and more densely settled metro areas with higher income and better-educated residents have more efficient and successful casinos than those in smaller and more sprawled or semi-rural areas with lower incomes. In fact, none of the casinos in Iowa, the most rural of the five states examined, had CRS efficiency scores of 1.0, and the casinos that were not in either a metro or micropolitan area failed to score 1.0 when it came to CRS efficiency. Interestingly, given the Urban Economics Index composition, areas with higher unemployment rates and greater degrees of inequality also have higher degrees of casino success, an aspect which may be the result of negative externalities associated with large urban size rather than a symptom of exploitation of casino patrons.

Weather factors such as average yearly temperature and annual precipitation also matter. Casinos and those with racetracks in warmer climate zones with less precipitation tend to do better on average than those in colder and wetter areas. Missouri and Louisiana have 8 casinos/racinos with scores of 1.0 out of the 11 establishments out of 66 which scored 1.0 on CRS efficiency.

Although the Border Effect variable does not work well in either the Tobit or OLS models, the coefficient has the hypothesized sign (positive) and in the OLS regression, is significant at $p < 0.10$. Perhaps this variable did not work that well because the overwhelming majority of the casinos were on borders between states (54 out of 66).

Table 6 displays the Tobit and OLS regression results for the VRS efficiency scores as dependent variables. The explanations of variation (a low absolute log-likelihood value for the Tobit model and a low adjusted r-square for the OLS model) are even lower than those for the models using CRS efficiency as a dependent variable. Only the two weather related variables are significant in the VRS efficiency models. VRS efficiency assumes that inputs and outputs are not in fixed proportions (for example, a doubling of inputs leads to a doubling of outputs in constant returns to scale) so that increasing and decreasing returns to scale are possible (a doubling of inputs could lead to a tripling of outputs if there are increasing returns to scale). Therefore, market area size and other demographic factors are not going to matter as much in predicting a casino's success since a small casino in a small market could show efficiency if the casino is assumed to be getting its output due to increasing returns to scales, such as Wild Rose Casino in Emmetsburg, Iowa, a small casino which scores 1.0 in VRS efficiency yet only 0.43 in CRS efficiency. Because inputs and output ratios are not fixed in VRS efficiency, a higher number of casinos are able to achieve efficiency scores of 1.0 when compared to CRS estimation (20 for VRS versus 11 for CRS). The advantage of CRS models is that they are a middle ground between increasing and decreasing returns to scale models, and they are important to economic theory since constant returns to scales assumes economic efficiency of operating units in the first place (Nicholson 1989, page 283) and then looks for departures from constant returns to scales in order to assess efficiency. Therefore, most papers involving DEA techniques mostly focus on CRS efficiency results.

DISCUSSION AND CONCLUSION

This paper has a few important public policy implications for casino or racino operations and their locations. Despite the intuitive logic of locating casinos and racinos in large metro markets, some have been located in small micropolitan areas and some in areas that are neither metropolitan or micropolitan. These locations are sub-optimal according to the DEA results and the regression analyses. Perhaps political considerations explain the location of some casinos in small towns and semi-rural areas since state governments have to license and permit different casino sights.

Even those casinos in large metro areas show variations in success and efficiency perhaps because of their location within the metro area. Those casinos in fringe and less populated counties of a metro area do not seem to fare as well as those in the central county of a metro area since the variable "Density Index of the Home County" variable is moderately correlated with (r = 0.41) with the CRS efficiency scores. Horseshoe Casino in Elizabeth, Indiana is in the Louisville, Kentucky-Indiana MSA yet is in sparsely settled Harrison County, Indiana and is a 30-minute drive from most Louisville-Jefferson County Kentucky neighborhoods, which is where around 70% of the metro area's population is located, and the casino scores around 0.77, less than efficient. Five of the eleven CRS efficiency scores of 1.0 belong to casinos or racinos that are located in the central county of a MSA.

Interestingly three of the eleven CRS efficient casinos are also racinos which have horseracing, and the horse racing racino Harrah's Louisiana Downs in Shreveport comes close to efficiency with a score of 0.91. Despite a downturn in casino attendance and revenues over the last few years, racinos are doing well and show rising profits (American Gaming Association, 2009, page 2). Any new casinos locating in a state should consider partnering with a racetrack or should be racetrack owned if current trends continue.

With Ohio voters approving casino gaming in 2009 and with Kentucky political leaders debating casino legalization (Gerth, 2010), the recommendation of this paper would be for these states, which would be regional competitors with four of the five states examined in this paper, to locate casinos in the largest metro markets possible and to link future casinos with racetrack establishments if possible. For the last few years in Kentucky, Churchill Downs has lobbied unsuccessfully to have slot machines allowed in its Louisville racetrack (Gerth, 2010) in order to compete with casinos located in Southern Indiana and to raise more revenue. Given the efficiency scores of the racinos examined in this paper, Churchill Downs' reasoning seems sound.

Although the border effect variable was not statistically significant, it is highly probable that Ohio will locate casinos in border areas in order to compete against casinos in adjoining states just as Kentucky would do so in order to prevent casino losses to Indiana and to possibly draw patrons from Tennessee, where there is no casino gaming. Ideally, border locations that correspond to large metro markets and include horseracing venues would be the optimal choices. Although weather variables are beyond the control of policy makers, one would expect that weather would favor locations in southern Ohio and Kentucky, everything else held constant, when compared to locations further north.

The results of this study are limited by the fact that Mississippi does not have the appropriate data for analysis, so some important data is missing, and the data envelopment analysis is cross-sectional and does not look at the performance of these casinos over time, although the demographic, geographic, social and weather data used in the Tobit regression only change slowly over time. As a suggestion for further research, some scholarly work could be done on how much political influence is involved in choosing casino location to see if that plays a role in the choice of some (if not all) of the sub-optimal locations of casinos. It is highly possible that state governments grant casino licenses in less than efficient locations due to political considerations or pressures, or due to the fact that the voters in some optimal locations resist and reject being chosen for casino locations. Although there may be optimal locations for casinos that can yield the best tax revenues, these same locations may not be politically viable for various reasons.

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BIOGRAPHY

Dr. Thomas E. Lambert is a Lecturer in Economics in the School of Business at Indiana University Southeast. He has a PhD in Urban and Public Affairs from the University of Louisville, a MS in Economics from the University of Kentucky, and a MBA from the University of Louisville and has taught and done research in the areas of urban economics and public policy. He has published in the journals *Benchmarking: An International Journal*, *Economic Development Quarterly, International Journal of Housing Markets and Analysis, Journal of Economic Issues, Journal of Transportation Management, Population Research and Policy Review, Social Science Quarterly, State and Local Government Review,* and *Transportation Journal.* He can be contacted at School of Business, Indiana University Southeast, New Albany, Indiana 47150, US. E-mail: tlambert@iupui.edu

Dr. Arun K. Srinivasan is an Assistant Professor of Economics in the School of Business at Indiana University Southeast. Arun received his PhD in Economics from the University of Kentucky, Lexington in 2004. He has conducted applied economics research studies in the areas of environmental economics, urban economics, economics of education and international economics. His research has been published in journals like *Journal of Environmental Management, Indian Journal of Economics and Business*. and *Benchmarking: An International Journal*. Before coming to the US, Arun was employed as a Research

Associate in a forestry project funded by the Government of India. He can be contacted at School of Business, Indiana University Southeast, New Albany, Indiana 47150, US. E-mail: asriniva@ius.edu

Dr. Uric Dufrene is Professor of Business Administration and is the holder of the Sanders Chair in Business at the IU Southeast School of Business. He teaches corporate finance at both undergraduate and graduate levels, and his current research interests include regional economic trends. He obtained his BS and MBA from Nicholls State University in Thibodaux, Louisiana and his Ph.D. from the University of Mississippi. Prior to holding the Sanders Chair in Business, Professor Dufrene served as dean of the School of Business for 7 years. He gives the annual economic outlook for Southern Indiana and Greater Louisville at the school's annual Economic Outlook Breakfast and Mid Year Outlook programs.

Dr. Hokey Min is James R. Good Chair in Global Supply Chain Strategy in the College of Business Administration at the Bowling Green State University. Prior to joining the Bowling Green State University, he was the Distinguished University Scholar and Founding Director of the UPS Center for World-wide Supply Chain Management and the Center for Supply Chain Workforce Development at the University of Louisville. He earned his Ph.D. degree in Management Sciences and Logistics from the Ohio State University. His research interests include global logistics strategy, benchmarking, and supply chain modeling. He has published more than 135 articles in various refereed journals including European Journal of Operational Research, Journal of Business Logistics, Journal of the Operational Research Society, International Journal of Production Research, Transportation Journal, and Transportation Research. He is currently serving as the Editor of International Journal of Logistics: Research and Applications and is serving on the editorial review board of International Journal of Integrated Supply Management and Benchmarking: an International Journal. He can be contacted at College of Business, Bowling Green State University, Bowling Green, Ohio 43403 , US. E-mail: hmin@bgsu.edu