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Endogeneity in Casino Revenue and Crime Rates: The Case of Las Vegas, Nevada*

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Abstract: This paper investigates relationships among casino revenue, crime rates, and the number of visitors in Las Vegas, Nevada. Numerous studies have attempted to assess the impact of casino activities on crime rates but have provided inconclusive results. Some studies have found that casino activities increase crime rates, while others find no significant relationship between casino gambling and crime rates. But all studies that have found casinos increase crime rates do not adjust the crime rate for the number of visitors to the area. The impact of casino activities on crime rates disappears, however, when crime rates are adjusted for visitors. This study revisits the question with consideration for the potential endogeneity among variables. This paper addresses endogeneity concerns by estimating the impact of casino activities on crime using a system of equations to represent casino activities, adjusted crime rates, and visitors. Three stage least squares is used to estimate the system. Results show that the impact of casino activities on crime rates persists even after crime rates are adjusted for the visitors. Efforts to reduce crime can be effective in boosting the Las Vegas regional economy.

Keywords: casino, endogeneity, crime rate
JEL Codes: C36, K4, L83, R11

1. INTRODUCTION

In 2013, there were about 1,000 casinos operating in 39 states in the U.S. Casinos, including those owned by Native American tribes, generate revenues of over $67 billion ($39 billion for commercial casinos) (American Gaming Association [AGA], 2014). These casinos employed more than 554,000 people and paid almost $26 billion in wages (AGA, 2014). According to Bazelon, Neels, and Seth (2012), the commercial casino industry supported $125 billion in spending and nearly 820,000 jobs in the U.S. economy (in 2010) including direct, indirect, and induced impacts.[1] As shown in the panel A of Figure 1, casino revenue has

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[1] Economic impacts are based on consumer (visitors) expenditures (direct effect) in casinos. These expenditures affect the local and regional economy through the inter-industry relationships among different sectors and industries of the local economy (Miller and Blair, 2009). Casino visitors' expenditures on, say, food and lodging, cause business-to-business (upstream, or indirect effects) exchanges as retailers make purchases from wholesale suppliers. Downstream effects (i.e., induced effects) occur as those employed by retailers and wholesalers use their wages to buy homes, cars, food, entertainment, etc. in the region (GAO, 2000).

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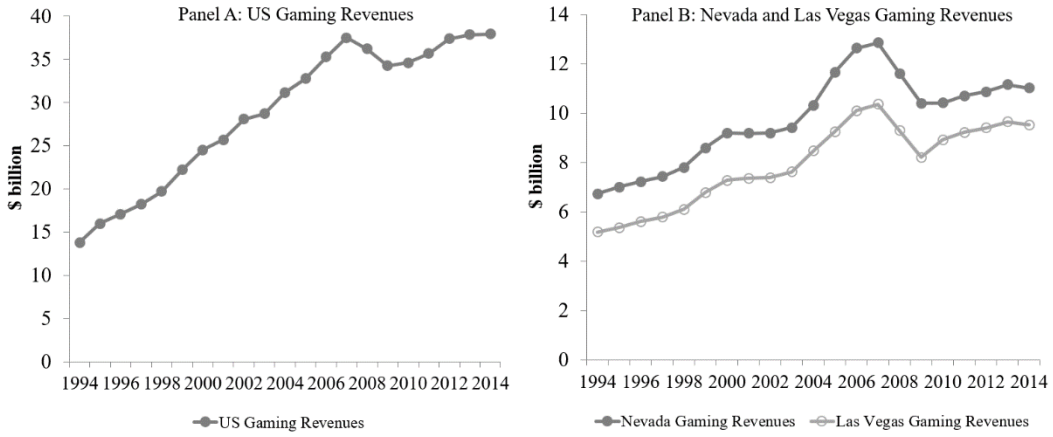
increased considerably over the past two decades, despite a slowdown in 2008-2009. The casino revenues of Las Vegas (Clark County, see endnote iii) and the State of Nevada are shown in the panel B of Figure 1. The growth of the gambling industry in Las Vegas (Clark County) has influenced policymakers in other areas, especially regions without much competitive industry, to legalize casino gambling. Walker (2010, p. 488) points out that there is a "new wave of commercial casino legalization."

Although the casino industry has become more prosperous, concerns about the potential for crime and other negative impacts have made community leaders and residents reluctant to allow legalized gambling. According to AGA (2012), the potential negative impacts that casinos may bring to communities include crime and prostitution, and these impacts may "…hurt the image of communities where they are located…" (AGA, 2012, p. 27).[2] In August 2012, the Governor of Illinois, Pat Quinn, vetoed the expansion plans of Chicago casinos that would have added five new casinos to the state (*Chicago Tribune*, 2012). In his veto message, Quinn said "the state must not allow ethical shortcomings that allow loopholes for mobsters" (*Chicago Tribune*, 2012).

Many studies (summarized in Table 1) have attempted to answer the question of whether or not the introduction or the expansion of casino gambling increases crime incidence in the region. According to Walker (2010), early studies published during 1985-2000 suggested that casino gambling caused higher crime rates (Friedman, Hakim and Weinblatt, 1989; Hakim and Buck, 1989; Giacopassi and Stitt, 1993). This is consistent with the intuition that if there is an increase in population and visitors in an area stimulated by the casino activities, more crime is likely to result. But some other early studies did not find a meaningful relationship between casino gambling and crimes (Albanese, 1985; Curran and Scarpitti, 1991; Chang, 1996; Stokowski, 1996). Recent studies, those published from 2001 through 2010, have relied on more complete data, larger markets, and, often, more advanced econometric techniques. Despite all of this, the findings on the relationship between crime and gambling remain mixed. Gazel, Rickmand, and Thompson (2001), Evans and Topoleski (2002), and Grinols and Mustard (2006)

Figure 1: Casino Revenues, 1994-2014



Source: American Gaming Association; Nevada Gaming Commission and State Gaming Control Board

[2] The AGA reports that almost nine out of ten community leaders—e.g., senators, mayors, city and county council members, fire or police chiefs, district attorneys and so on—disagree, saying this is not the case (AGA, 2012, p. 27).

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claim that casinos increase crime rates. While Wilson (2001), Barthe and Stitt (2007, 2009a, 2009b), Clark and Walker (2009), and Reece (2010) find no statistically significant relationship between casinos and crime.

Table 1: Casino-Crime Studies, 1985-2010

Study	Journal	State/region studied	Year analyzed	Year casino opens	Casinos increase crime rate?	Population adjusted for visitors
Albanese (1985)	*Federal Probation*	Atlantic City	1978-1982	1978	No	Yes
Friedman et al. (1989)	*Journal of Regional Science*	Atlantic City	1974-1984	1978	Yes	No
Hakim and Buck (1989)	*Journal of Criminal Justice*	Atlantic City	1972-1984	1978	Yes	No
Curran and Scarpitti (1991)	*Deviant Behavior*	Atlantic City	1985-1989	1978	No	Yes
Giacopassi and Stitt (1993)	*Journal of Criminal Justice*	Atlantic City	1991-1993	1992	Yes	No
Chang (1996)	*Journal of Criminal Justice*	Biloxi, MS	1986-1994	1992	No	Yes
Stokowski (1996)	*Journal of Travel Research*	Biloxi, MS	1989-1994	1991	No	Yes
General Accounting Office (2000)	*US General Accounting Office*	Atlantic City	1977-1997	1978	No	Yes
Gazel, Rickman and Thompson (2001)	*Managerial and Decision Economics*	Wisconsin	1981-1994	(Tribal)	Yes	No
Wilson (2001)	*Crime & Delinquency*	Indiana	1992-1997	1995	No	No
Evans and Topoleski (2002)	*NBER Working Paper*	National (tribal only)	1985-1989	(various)	Yes	No
Stitt, Nichols and Giacopassi (2003)	*Crime & Delinquency*	Various	1980s-1990s	(various)	Mixed	Yes
Betsinger (2005)	*University of Maryland Thesis*	144 counties in 33 states	1977-2001	(various)	Mixed	No
Grinols and Mustard (2006)	*Review of Economics and Statistics*	All US counties	1977-1996	(various)	Yes	No
Barthe and Stitt (2007, 2009a, 2009b)	*Journal of Gambling Studies*	Reno, NV	2003	1937	No	Yes
Clark and Walker (2009)	*International Gambling Studies*	Various	1994–1995, 1996, and 2001–2002	(various)	No	Yes
Reece (2010)	*Contemporary Economic Policy*	Indiana	1994-2004	1995	No	Yes

Source: Modified from Table 19.2 and Table 19.3 in Walker (2010); authors added the last column

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It is notable that all studies that find casinos increase crime rates do not account for the number of visitors to the area (see the last two columns in Table 1). If crime rates simply are calculated as crimes per permanent resident rather than crimes per person, reported crime rates may be misleadingly high (Albanese, 1985). Furthermore, Albanese (1985) concludes that the estimated risk of being victimized decreases when the crime rate accounts for visitors as well as residents. Similar results are found by Miller and Schwartz (1998) and Walker (2008, 2010).

Somewhat surprisingly, all studies listed in Table 1 ignore the potential endogeneity between crime rates and casino revenues (activities). Endogeneity, or simultaneous determination, occurs between casino activities and crimes because bi-directional causality may exist between them, as discussed in the following sections. Failure to account for this endogeneity can lead researchers to incorrect conclusions. Estimating the effect of casino gambling on crime rates, while addressing this potential endogeneity among variables, is our primary research goal. The second goal of the study is to show that the impact of casino activities on crime still exists even after adjusting crime rates for the number of visitors. To address our research objectives, we build a simultaneous-equations system to estimate the effect of casinos on crime (and vice versa) for Las Vegas, Nevada.[3]

This paper is structured as follows: Section 2 explores the previous literature and discusses the importance of addressing possible endogeneity. Section 3 outlines the structural model and methodology used in the study. Section 4 explains the data, key variables in the model, and discusses the estimation results. Section 5 concludes the study, with a focus on policy implications.

2. PREVIOUS RESEARCH

There have been numerous studies investigating the relationship between casino gambling and crime since New Jersey legalized commercial casinos in 1978. Still, some uncertainty remains regarding as to whether or not casino gambling increases crime. Grinols and Mustard (2006) explained the dual effects that casino gambling may have on crime rates. Casino gambling may increase crime by leading to illegal casino-related activities, increasing the potential payoffs of crime, bringing in pathological gamblers, bankruptcy, usurious loans, and fraud, attracting more visitors and visitor criminals, and drawing low-skilled labors. On the other hand, casino activities may decrease crimes by offering jobs to locals and providing more tax revenue to maintain law enforcement. Walker (2010) supported this view by pointing out that most casinos are now operated by corporate owned and managed entities, not mob money-laundering operations.

Studies can be classified into two groups. The first group is a series of studies that support the view that casino gambling increases crime in a region. A second group of literature indicates that casino gambling does not increase crime in a region. Friedman, Hakim and Weinblatt (1989) and Hakim and Buck (1989) used similar regression analyses with panel data from the years before and after the casinos opened in Atlantic City, New Jersey. Both studies find that the level of crime was higher in the post-casino years than the pre-casino years. Grinols

[3] The study area is Clark County, Nevada, which is located in southern Nevada and has the same spatial or temporal scope with Las Vegas-Henderson-Paradise Metropolitan Statistical Area (MSA). As of 2010, the county's population was close to two million, the most populous in Nevada. In 2000, this MSA included neighboring Nye County, Nevada, as well as Mohave County, Arizona. This study considers only Clark County.

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and Mustard (2006) examined county-level crime data in U.S. counties from 1977 through 1996 and concluded that casinos increased all crimes except murder. Clark and Walker (2009) found that there are some positive links between gambling and criminal activity.

In contrast, the effect of casino gambling on crime is not found (or mixed results are found) in some studies. Giacopassi and Stitt (1993) divided crimes into different categories and examined the effect of the introduction of casinos on each type of crime. They concluded that there was no significant difference before and after the introduction of casinos using the data for Biloxi, Mississippi. Chang (1996) also measured the impact of casinos on crime on the basis of data collected from Biloxi, Mississippi, but failed to find evidence that casino gambling increased crime rates during the first two years of casino introduction. Stitt, Nichols and Giacopassi (2003) compared crime rates in six new casino jurisdictions to six non-casino communities and showed that crime did not rise with the introduction of a casino. Betsinger (2005) examined the impact of gambling revenues on county-level crime rates. The results were mixed, some types of crimes increased while other types decreased. Reece (2010) introduced new control variables, (the number of hotel rooms, turnstile counts of patron, and law enforcement), which were missing in previous studies. He found limited evidence to support the proposition that new casinos increase local crime rates.

3. RESEARCH APPROACH

3.1 Endogeneity

Casino gambling may dampen or enhance crime levels (Grinols and Mustard, 2006), and both casino gambling and crime may influence the level of visitors. The complexity of this interaction may be a reason why previous studies did not consistently show either a positive or negative impact of casino activity on crime rates (see Table 1). It is noteworthy that some researchers have not considered the possible endogeneity issues present. Previous studies typically consider crime rates (or number of crime incidences) as the dependent variable and casino activities as the independent variable. Another limitation of most of the previous studies is that they use dummy variables to indicate the opening of a casino in the region because the studies compare the changes in crime before and after the introduction of a casino. An important contribution of this research is that we use a continuous measure (casino revenues) to represent the level of casino activities in the region.

If an increase in casino activity levels is associated with an increase in the crime rate, this increased crime rate may result in a decrease in the number of visitors (and perhaps the population) because the visitors (and locals) would undoubtedly try to avoid areas with higher crime rates. In turn, this effect would yield a negative effect on casinos revenues. Figure 2 illustrates this potential loop in the cause-and-effect relationships among crime, visitors, and casino activity. We model these effects via a system of simultaneous equations. The next section introduces the structural model. The symbol "+" in Figure 2 indicates a positive effect and the symbol "–" indicates a negative effect between variables. The question mark denotes an uncertain relationship between casino activity and crime that will be discussed in the next section.

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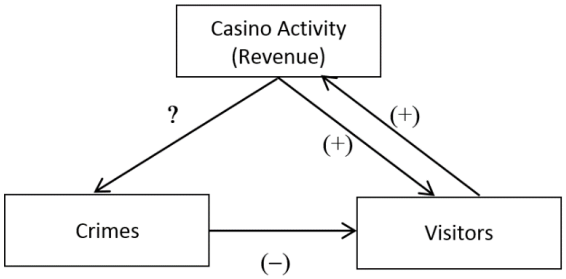
Figure 2: A Potential Causality Loop



Note: The symbol "+" indicates a positive effect, and the symbol "–" indicates a negative effect between variables. The arrow shows the potential causal flow. The question mark between casino activity and crimes indicates an uncertain relationship.

3.2 Simultaneous Equations Model

To deal with endogeneity among variables, we construct a system of equations describing casino activities, visitors, and crime rates. Casino revenue, our proxy for casino activities, is a function of the number of visitors. Macroeconomic economic conditions may also affect the casino revenue. We use the Dow Jones Industrial Average (DJIA) as a composite proxy for these conditions. The casino revenue equation is given by:

$$(1) \qquad \ln rvn_t = \alpha_0 + \alpha_1 \ln vstr_t + \alpha_2 \ln dow_t + \alpha_3 T + \sum_{i=1}^{i=11} \gamma_{1i} month_i + \varepsilon_{1t},$$

where t is the subscript for time (month), rvn is the casino revenue, $vstr$ is the number of visitors, dow is the Dow Jones Index, and T is a monthly trend variable denoting the count of the month. The trend variable captures effects that are correlated with time. Lastly, the variable $month$ is a monthly dummy that captures seasonality in casino revenue. The number of visitors is expected to have a positive impact on casino revenue. The sign of dow is also expected to be positive. The casino revenue equation has one endogenous variable ($vstr$) and thirteen exogenous variables (dow, T, $month_i$).

We model visitors as a function of casino revenue, the crime rate, and a proxy for general economic conditions. We make the distinction in equations between casino revenue and the number of visitors because these two variables do not measure the same phenomenon. Many people go to Las Vegas for non-casino related activities and functions such as sightseeing, shopping, attending conferences, etc. (GLS Research, 2014). According to GLS Research (2014), the proportion of visitors who gamble while visiting Vegas is approximately 71 percent to 72 percent (GLS Research, 2014), and the average trip gambling budget (among those who gambles) for the group of 2.4 persons is estimated to be $530 (roughly $220 per visitor, which is roughly 43 percent of total visitors' expense). The visitor equation is:

$$(2) \qquad \ln vstr_t = \beta_0 + \beta_1 \ln rvn_t + \beta_2 \ln crm_t + \beta_3 \ln dow_t + \beta_4 T + \sum_{i=1}^{i=11} \gamma_{2i} month_i + \varepsilon_{2t},$$

where crm is the crime rate. The expected sign of casino revenue is positive (more casino activities attract more visitors), and the expected sign of crime is negative (visitors tend to avoid high crime areas). The expected sign of dow is expected to be positive. The visitor equation contains two endogenous variables (rvn, crm) and thirteen exogenous variables (dow, T, $month_i$).

Our crime equation includes casino revenue and the DJIA. We drop the number of visitors from the crime equation because the crime rate includes visitor information in it, i.e., the

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number of visitors is used to calculate the adjusted crime rate. The crime equation includes the crime clearance rate that measures the deterrence or effectiveness of law enforcement. More explanations on the crime clearance rate follow in the next section. The crime equation is given by:

$$(3) \quad \ln crm_t = \delta_0 + \delta_1 \ln rvn_t + \delta_2 \ln clear_t + \delta_3 \ln dow_t + \delta_4 T + \sum_{i=1}^{i=11} \gamma_{3i} month_i + \varepsilon_{3t},$$

where $clear$ is the crime clearance rate. The crime equation contains one endogenous variable (rvn), and fourteen exogenous variables ($clear$, dow, T, $month_i$).

3.3 Estimation and Elasticities

There are several methods for estimating simultaneous equations. Two-stage least-squares (2SLS) is consistent but ignores information concerning the endogenous variables which appear in the system but not in individual equations (Judge et al. 1988). A seemingly unrelated regression (SUR) accounts for the correlation in the error terms across equations but does not consider the endogenous nature of the problem. Three-stage least squares (3SLS) is considered a combination of 2SLS and SUR. It accounts for the contemporaneous correlation in the error terms across equations and the correlation of the right hand side variables with the error term. Furthermore, it is asymptotically more efficient than 2SLS (Judge et al. 1988). Thus, we adopt 3SLS to estimate the system of equations.

Key elasticities are calculated using the chain-rule from the system of equations such that:

$$(4) \quad \text{Elasticity of casino revenue w. r. t crime: } \frac{\partial \ln rvn}{\partial \ln crm} = \frac{\partial \ln rvn}{\partial \ln vstr} \cdot \frac{\partial \ln vstr}{\partial \ln crm} = \alpha_1 \beta_2$$

$$(5) \quad \text{Elasticity of crime w. r. t casino revenue: } \frac{\partial \ln crm}{\partial \ln rvn} = \delta_1$$

4. STUDY REGION, DATA COLLECTION and KEY VARIABLES

We select Las Vegas, Nevada, as our study region because the casino business has long been one of the most important industries in the region. Another reason is that there is, to our knowledge, no study investigating the relationship between casino and crime specifically in Las Vegas (See Table 1). In previous studies, researchers have focused on how the introduction of casinos would affect crime (or the crime rate), i.e., changes in crime (or crime rates) before and after casino introduction. Unfortunately, in Las Vegas it is impossible to use crime data from before gambling was legalized in 1931 since no such data were collected then. The data set for the empirical analysis is comprised of monthly data spanning from January 1996 to December 2013 (216 observations). Basic statistics of all variables are reported in Table 2.

4.1 Crime Rate

The crime data are compiled from the Uniform Crime Reports (UCR) in the Nevada Department of Public Safety. Two types of crime rates, a reported crime rate and an adjusted crime rate, are calculated based on, respectively, the population and the population adjusted for visitors, as suggested in Albanese (1985) and Walker (2008). Panels A and B in Figure 3 show the reported crime rates and the adjusted crime rates in Las Vegas between January 1996 - December 2013. The reported crime rate (Panel A in Figure 3) and the adjusted crime rate (Panel B in Figure 3) are decreasing over time.

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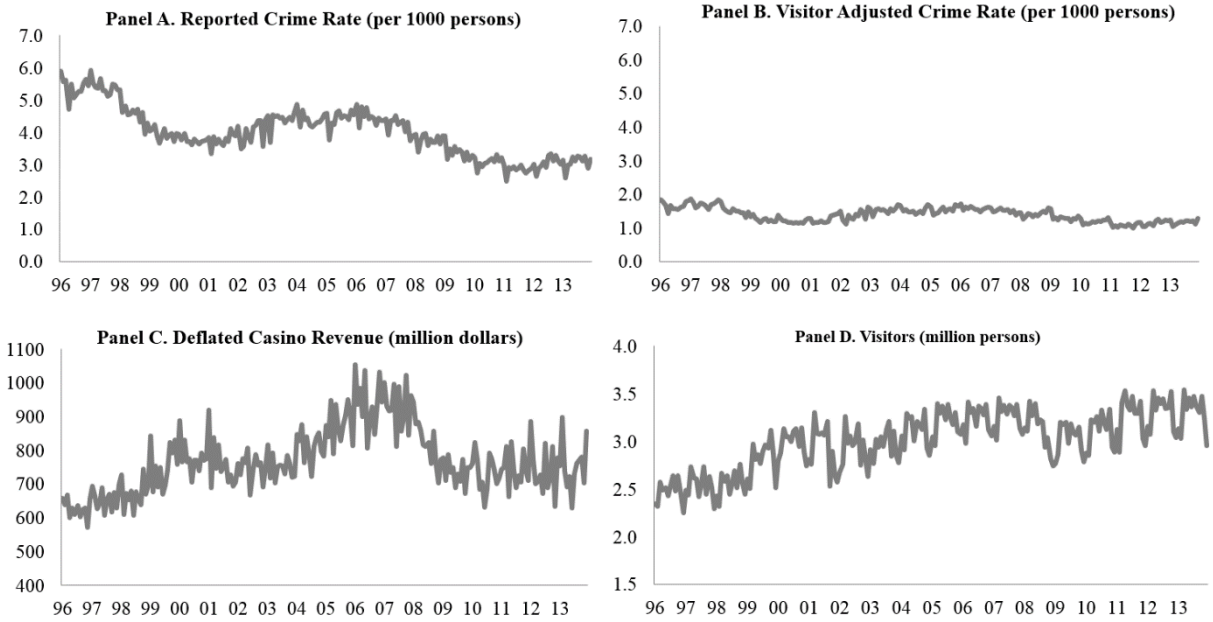
4.2 Casino Revenue

Researchers have used different measures of casino activity; for example, Grinols and Mustard (2006) used dummy variables to indicate the beginning of casino activity in an area. Reece (2010) used the number of hotel rooms and Betsinger (2005) used the number of slot machines as indices for casino activity. We use casino revenue as an index of gambling activity. Casino revenue is the money that consumers spent gambling. Casino revenue data are obtained from the Nevada Gaming Commission and the State Gaming Control Board and deflated using GDP deflators (Panel C in Figure 3). From Panel C in Figure 3, we find that casino revenue has strong seasonality and starts decreasing at the end of 2007. It is likely that decreases in casino revenue stem from the financial economic crisis in late 2000s.

4.3 Visitors

The visitor data are obtained from the statistical reports of the Las Vegas Convention and Visitor Authority (http://www.lvcva.com/stats-and-facts/visitor-statistics/). Panel D in Figure 3 shows the trend of the number of visitors to Las Vegas from January 1996 - December 2013. As shown in Panel D in Figure 3, there exists strong seasonality in visitor counts.

Figure 3: Plots of Key Variables (January 1996 – December 2013)



Data sources: crime rate from Uniform Crime Reporting (UCR) in Nevada Department of Public Safety; casino revenue from Nevada Gaming Commission and State Gaming Control Board; visitors from Las Vegas Convention and Visitor Authority

4.4 Other Variables

We use the Dow Jones Industry Average (DJIA) as an index of U.S. economic conditions. When the DJIA is high, the U.S. economy is likely to be performing well, and, thus, it should stimulate people to visit the Las Vegas area. The DJIA is obtained from EconStats (www.econstats.com). The clearance rate in Equation (3) is calculated by dividing the number of crimes that are cleared (charge being laid) by the total number of crimes reported from the UCR

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in the Nevada Department of Public Safety. Simply, it is the rate at which crime is solved by the authorities, i.e., police.

Table 1: Basic Statistics for Key Variables

	Visitors (million)	Casino Revenue (million $)	Number of Crimes (cases)	Crime Rate (per 1000 persons)	Adjusted Crime Rate (per 1000 persons)	Clearance Rate (%)
Mean	3.022	706.97	6,372	3.97	1.37	21.43
St.Dev.	0.315	130.17	882	0.77	0.23	3.62
CV	10.41	18.41	13.85	19.34	17.12	16.90
Min	2.250	442.79	4,790	2.50	0.13	11.36
Median	3.069	715.53	6,245	3.92	1.39	21.78
Max	3.688	1,001.32	8,485	5.91	1.85	29.34

Table 2: 3SLS Regression Results with an Adjusted Crime Rate[a]

Equation	Variable	3SLS	OLS[b]
ln(*Casino Revenue*)	*ln(Visitors)*	1.8349***	0.5330***
		(0.109)	(0.164)
	ln(DJIA[c])	-0.0151	0.2472***
		(0.040)	(0.069)
	Trend	-0.0016***	-0.0007**
		(0.000)	(0.000)
	Constant	5.0051***	5.5965***
		(0.087)	(0.153)
	R^2	0.5910	0.8573
ln(*Visitors*)	*ln(Casino Revenue)*	0.6156***	0.0225
		(0.050)	(0.026)
	ln(Adjusted Crime Rate)	-0.1367***	-0.2438***
		(0.036)	(0.035)
	ln(DJIA[c])	-0.0480	0.0498
		(0.031)	(0.044)
	Trend	0.0008***	0.0008***
		(0.000)	(0.000)
	Constant	-3.0040***	0.7481***
		(0.270)	(0.179)
	R^2	0.8418	0.8359
ln(*Adjusted Crime Rate*)	*ln(Casino Revenue)*	0.1923**	0.0610
		(0.097)	(0.051)
	ln(Clearance Rate)	-0.3167***	-0.1643***
		(0.038)	(0.043)
	ln(DJIA[c])	-0.3534***	-0.2021**
		(0.048)	(0.083)
	Trend	-0.0006***	-0.0008*
		(0.000)	(0.000)
	Constant	0.9852	1.0600***
		(0.659)	(0.397)
	R^2	0.6799	0.4343

Note: Numbers in parentheses are standard errors. Significance levels are 1 percent (***), 5 percent (**), and 10 percent (*).
[a] Monthly dummies are omitted to save space; [b] Serial correlation is detected in all three equations using the Breusch–Godfrey test. The Prais–Winsten process is used to obtain robust standard errors assuming first-order serial correlation; [c] Dow Jones Industrial Average

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5. RESULTS AND DISCUSSION

5.1 Casino Revenue, Visitors, and Adjusted Crime

Results for our system of equations with the adjusted crime rate are presented in Table 3. Table 3 also contains, for comparison purposes, the analogous results for single equation models using ordinary least squares. From Table 3 we observe the following:

Casino revenue equation (Equation 1): The coefficient on the *Visitors* variable is positive and statistically significant, i.e., more visitors are associated with more casino revenues, as expected. The coefficient of the Dow Jones index (DJIA) is statistically insignificant which is different from expectations; the coefficient implies that casino revenues are not statistically related to the Dow Index. This could be interpreted as a large tourist destination like Lag Vegas might be impervious to the Dow Jones index or other economic indicators. Smaller gaming jurisdictions might be more susceptible to the economic situation. The single OLS equation model results are similar but of different magnitudes, especially, the economic situation (Dow Jones variable) has a much stronger impact on the casino revenue.

Visitor equation (Equation 2): We find that the coefficient on the casino revenue variable is positive and statistically significant, i.e., more casino activities are associated with more visitors. The sign of the adjusted crime rate is, as expected, negative and statistically significant, indicating that higher crime rates do indeed crowd out visitors from the region. The *Dow* has a negative sign but is statistically insignificant, which is interesting; perhaps, ceteris paribus, people tend to purchase other types of entertainment rather than casino gambling when the economy is good. The single-equation results show similar patterns, but both *Casino revenue* and the *Dow* are not statistically significant. The adjusted crime rate has stronger impact on the number of visitors in the single OLS equation model.

Adjusted crime equation (Equation 3): The coefficient on casino revenue is positive and statistically significant, which implies that casino activities are associated with an increase in the adjusted crime rate. Moreover, we note that the coefficient on casino revenue in the single OLS equation model is not statistically significant. This result suggests that failure to account for the endogenous nature of the problem can strongly influence the statistical results. The results obtained by the OLS equation are consistent with findings in other studies, such as Walker (2008), that find no significant impact of gambling activity on crime rates (See Table 1). As expected, the crime *Clearance rate* has a negative coefficient and is statistically significant, indicating that the effectiveness of law enforcement has a negative effect on the adjusted crime rate. The *Dow* coefficient is also negative and statistically significant, which is consistent with our intuition.

Elasticities are derived using the chain rule as discussed in Equations (4) and (5) and reported in Table 4. When the adjusted crime rate increases, it leads to a decrease in the number of visitors and casino revenues. The *Casino revenue* elasticity with respect to the *Adjusted crime rate* is estimated to be -0.25 percent with a 95 percent confidence band given by -0.37 percent to -0.14 percent. This implies that casino revenue decreases by 0.14 percent to 0.37 percent when the adjusted crime rate increases by 1 percent. But a 1 percent increase in casino revenue is associated with an increase in the *Adjusted crime rate* of 0.19 percent. We note, however, that the 95 percent confidence band associated with this estimate (0.01 percent to 0.38 percent) is quite large.

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Table 3: Estimated Elasticities with 95 percent Confidence Bands

	Elasticities		
Of / w.r.t	*Revenue*	*Visitors*	*Adjusted Crime Rate*
Adjusted Crime Rate	-0.251 [-0.366, -0.136]	-0.137 [-0.206, -0.067]	
Visitors	0.616 [0.518, 0.714]		0.353 [-0.002, 0.708]
Casino Revenue		0.616 [0.518, 0.714]	0.192 [0.001, 0.383]

Numbers in brackets are 95 percent confidence bands. Confidence bands are constructed based on the estimated variance-covariance of the estimated parameters in Table 2.

Note: The numbers are elasticities. For example,-0.251 means if the adjusted crime rate increases by 1 percent, casino revenue will decrease by 0.251 percent.

5.2 Reducing Crime Rates and Regional Economic Impact

Efforts to reduce crime can be an effective tool to boost the regional economy (in Las Vegas). For example, a one percent lower (adjusted) crime rate increases the number of visitors by 0.137 percent (Table 1), which is roughly 56,300 more visitors assuming 41 million visitors in a year (2014 visitors from Las Vegas Convention and Visitors Authority, http://www.lvcva.com/stats-and-facts/visitor-statistics/). The visitor expenditure in this region is estimated to be $507 per visitor during three nights of the stay on average (GLS Research, 2014, p. 8). This implies that a one percent lower (adjusted) crime rate brings an additional $28.5 million dollars to the region. The food and drink sector takes an additional $6.6 million, hotel/lodging $6.5 million, retail sectors $3.5 million, and local transportation $1.6 million. Additional expenditure on the casino gambling industry is estimated to be $8.8 million assuming 70 percent of visitors gamble (GLS Research, 2014, p.8). Using the IMPLAN input-output model for Clark County in 2013, we estimate the total regional economic impact (direct + indirect + induced) to be $50 million. So the one percent lower (adjusted) crime rate may add 448 jobs to the region.

6. CONCLUDING REMARKS AND POLICY IMPLICATIONS

This study revisits the question of whether casinos increase crime rates. Some studies have found that casino activities increase crime rates but others do not find a meaningful relationship between casino gambling and crime. These differences can be explained by noting that studies that have found that casinos increase crime rates did not adjust the crime rate for visitors. The impact of casino activities on crime rates disappears, however, in studies where crime rates are adjusted for the visitors.

A system of three equations representing casino revenue, visitors, and the adjusted crime rate is estimated using 3SLS (Table 3). Results show that the estimate of the effect of casino activity on the adjusted crime rate still exists, at least in Las Vegas. Using 3SLS to account for the potential endogenous nature of the variables, we find that the effect of casino activity on the adjusted crime rates is positive and statistically significant. But OLS estimates of this relationship are not statistically significantly different from zero.

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We estimate the elasticity of the crime rate with respect to casino revenue to be about 0.19 percent in Las Vegas. A one percent expansion of casino activity in Las Vegas (Clark County) is associated with about 12 more crime incidences per month.

Policy implications based on findings in this research include:

- Efforts to reduce crime can be effective tools to boost the regional economy. A one percent lower (adjusted) crime rate may bring 56,300 more visitors to the region and the total regional economic impact (direct + indirect + induced) is estimated to be $50 million. Also the one percent lower (adjusted) crime rate may add 448 jobs to the region.
- Cutting the link between casino gambling and crime is important: increases in casino activities attract more visitors and boost the regional economy. But the expansion of casino activities also increases the crime rate, and thus the effect of expansion is undermined.
- Cutting the link between visitors and crime is also important: the number of visitors has a negative relationship with crime which implies visitors avoid high crime regions.

Before concluding the study, three caveats should be addressed. First, casino revenue may not be an appropriate proxy variable for casino activities. Casino gambling, as a part of the entertainment industry in Las Vegas, only accounts for part of local tax revenues. There are many other industries affiliated with the casino industry such as hotels, restaurants, as well as tour and travel segments. Second, results in this article may not be applicable to other regions and thus may not be generalizable. Studies for other regions and the U.S. as a whole would be potential topics for future work. Third, in this article, crimes within casinos and outside casinos are not differentiated and thus the relationship between casino activities and local crime rates might be overestimated. Although data limitations prevent us from doing so, it may be beneficial to examine the impact of casino activities on different crime types because there may be certain types of crime that are more strongly tied to casinos.

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