MEASURING INDUSTRY EXTERNALITIES: THE CURIOUS CASE OF CASINOS AND CRIME

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Abstract

The philosophy of externalities and corrective policy is much better developed theoretically than it is in application. It falters at the roadblock of inability to measure the size of externalities. This paper exploits the connection between casinos, an industry that did not exist outside Nevada prior to 1978, and crime using county-level data for the US between 1977 and 1996, a period spanning the introduction of casinos to states other than Nevada. We articulate reasons why casinos may both decrease and increase crime. We show that casinos increased crime after a lag of 3 to 4 years, consistent with the theoretical predictions of the role of problem and pathological gamblers. Furthermore, by studying the crime rates in counties that border casino host counties we show that the data suggest casinos create crime, and not merely move it from one area to another: Neighbor county data indicate that casino crime spills over into border areas rather than is moved from them. Last, we explain why other studies have failed to identify a strong link between casinos and increased crime rates. The data indicate that 8 percent of crime observed in casino counties in 1996 was attributable to casinos. The average annual cost of increased crime due to casinos was $65 per adult per year.

JEL Classification Numbers: K0, K2, H2

Key Words: Casinos, Index I Crime, Externalities, Social Costs, Pigouvian Taxes

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The theory of externalities and corrective policy developed in the last one third century contains an impressive array of tools and techniques for improving social welfare in the presence of activity spillovers. Progress in applications has been much less pervasive than the advances in theoretical understanding, however. While the Clean Air Act allows trading in pollution rights, there is ongoing discussion of the taxation of carbon fuels and greenhouse gases, and in recent years there has been a growing campaign surrounding the recovery of social costs generated by industries whose products are believed to generate harmful externalities exemplified by lawsuits against the tobacco industry, in many other cases the attempt to implement rational mechanisms has foundered on the shoals of the inability to quantify the externality to be controlled or moderated. Application of Pigouvian corrective taxes, for example, requires information on the size of the externalities. Inability to implement quantifiable objectives is tantamount to failure to understand the most critical feature of the corrective process.

Occasionally, however, social science encounters serendipitous events, or clouds with silver linings, in the form of social experiments ready for testing. The casino industry is a case in point. Prior to 1978, there were no casinos in the United States outside of Nevada. Mainly since 1990, casinos have expanded to the point where the vast majority of Americans are now within relatively easy access of one. But, casino gambling is not just another entertainment. On a national basis, research suggests that it generates externality costs greater than $37 billion annually, making casino gambling one of a handful of the most costly social problems. Crime is one of the biggest components of these social costs. Crime is of great interest to the average citizen and crime statistics are widely kept, hence the connection between casinos and crime is an ideal object of empirical study. Unlike alcohol or illegal drugs, whose effects are confounded with many other contributing factors, the absence of casinos in most of the country until the recent past means that statistical before and after comparisons can be made to measure the impact of casinos on crime.

There are two further reasons why determining whether there is a link between casinos and crime, and how big, is particularly valuable. First, the casino industry has grown extremely rapidly in just the last decade and in that time has become one of the most controversial and influential industries. Commercial casino revenues increased 186 percent from $8.7 billion in 1990 to $24.9 billion in 1998.[1] Including Class III American Indian casinos,[2] 1998 revenues totaled $31.8 billion, or $163 per adult aged 20 or over. Casino industry revenues are now 71 percent as large as the cigarette market, while all forms of gambling are 30

[1]Gambling revenue is the net amount of money that the gambling operator extracts from patrons. It equals the "handle" (gross amount wagered—which may reflect the same chip being bet many times before it is ultimately retained or lost) less payouts, prizes, or winnings returned to players. For example, if players place wagers totaling $100,000 on outcomes of a roulette wheel over the course of an evening and $88,000 is returned to them as winnings (some roulette slots are reserved for the house), then operator revenue is $12,000.

[2]According to the Indian Gaming Regulatory Act of 1988, class I gambling consists of "social games solely for prizes of minimal value." Included in Class I gambling are traditional Indian games identified with tribal ceremonies and celebrations. Class II gambling includes bingo and "games similar to bingo." Class III gambling includes "all

percent bigger.[3] From 1982 to 1999 GDP increased 185 percent, while casino revenues increased more than 660 percent. This rapid casino expansion generated extensive debate about the impact of casinos on many social, economic, and political issues.[4] The casino industry has also become a major lobbying presence. For example, between 1992 and 1997, $100 million was paid in lobbying fees and donations to state legislators.[5] These concerns were sufficiently pronounced that the U.S. Congress established the National Gambling Impact Study Commission in 1996 to exhaustively study casinos. Its final report called for additional research and a moratorium on further expansion.

Research on the connections between casinos and crime to date has been inconclusive for a number of reasons that are detailed in Section I of the paper. Using a more comprehensive data set than past studies, Section I reviews the raw data on crime in counties with and without casinos. The evidence seems to point to a divergence in crime rates that arise after the introduction of casinos. Before adjustment or statistical corrections, it suggests that 11.7 percent of observed crime in casino counties is due to the presence of casinos. Other evidence seems to point in the same direction. For example, counties with American Indian casinos show a rise in crime rates across a range of crimes that coincides with the period after casino introduction. For the same number of years before casinos there is no similar change. In Florida, casino counties began the sample period with lower crime rates that the rest of the state, but end it with higher. Perhaps the strongest evidence, however, is the behavior of crime rates for casino counties when the data is grouped on year of casino introduction. Crime indexes that were flat for four years prior to casino opening take a small dip during the year of opening, but begin to rise several years after. The rest of the paper deals with examining this evidence for other contributory factors and documenting the theoretical and empirical connections between casinos and crime. After describing the connection between casinos and crime in the raw data in section I we critique the casinos and crime research. In section II we elaborate the theoretical links between casinos and crime before explaining our estimation strategy in section III. Section IV discusses our basic empirical results and section V extends the results to border counties. We find that crime begins to rise in casino counties with a lag of three years. Crime in border counties follows a similar pattern but attenuated to approximately half the level. This suggests that casinos are not just shifting crime from neighboring regions, but are creating crime. In section VI we use the estimates to formally calculate the crime-related social costs in casino counties. Our estimates place these costs at approximately $63 dollars per adult per year. Section VII summarizes and evaluates our research and suggests several fruitful avenues for further research.

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forms of gaming that are not Class I gaming or Class II gaming" such as blackjack, slot machines, roulette, and other casino-style games.

[3]Cigarette sales were $45 billion in 1997. Gambling revenues were $58.4 billion. See *International Gaming and Wagering Business*, August 2000, p. 15.

[4]Kindt (1994), Grinols (1996), Henriksson (1996), and Grinols and Omorov (1996) discussed a number of these.

[5] *The Wager*, 2, 39, 1997.

I. The Casino-Crime Context: What Do We Know?

Between 1977 and 1996, the years covered by our sample, the number of states with some form of casino gambling rose from one to 28.[6] The number of counties with casinos grew from 14 (all in Nevada) to nearly 170. At the end of the period, twenty-one states permitted casinos on Indian reservations. The Indian Gaming Regulatory Act of 1988 increased the number of Indian casinos by mandating that states allow American Indian gambling on trust lands if the state sanctioned the same gambling elsewhere. The semi-sovereign status of Indian tribes and their management by the Federal Bureau of Indian Affairs gave them greater leverage in their dealings with the states.

Table 1 presents summary crime, income, and population statistics for casino and noncasino counties (counties with no casino in any year of the sample). Casino counties had higher population, land area and income. Crime rates are also higher for these larger counties, as one would expect.

Figure 1 shows the aggregate relationship between the number of counties with casinos (left scale) and the crime rate (right scale). During the period 1977 to 1990, when the number of casinos was relatively constant, the crime rate fluctuated. However, we see that during the period between 1990 and 1996 when the number of counties with casinos increased rapidly, the crime rate dropped substantially. This contemporaneous casino growth and crime reduction is an important feature of the data. It has been used by some to suggest that casinos reduced crime. For example, Margolis (1997) stated, "crime rates in Baton Rouge, LA have decreased every year since casino gaming was introduced." However, such conclusions are not justified because many regions in the country experienced falling crime rates after 1991. Therefore, it is more appropriate to compare the magnitude of the decreases between casino and noncasino counties.

A. Evidence from National Data

1. Relative Crime Rates in the Post-Casino Period

Figure 2 contrasts the crime rate for casino and non-casino counties during the years 1991-96. The data are indexed so that 1991 = 100. Because data for Florida are missing in 1988 and 1996, Florida is not included.[7]

[6] One must carefully distinguish the date casinos began operating from other dates. Nevada (1931) legalized commercial casino gambling prior to the start of our sample, but in other states there were sometimes lags between the legislation authorizing casinos and the opening of operations. Within a state, different counties acquired casinos at different times. Also, bingo halls operated by American Indians converted to Class III gambling during our sample. We use the date Class III gambling operations first began in the county. The following states began some form of casinos gaming during our sample: Arizona (1992), Connecticut (1993), Colorado (1991), Delaware (1995), Florida (1982), Georgia (1995), Idaho (1993), Illinois (1991), Indiana (1995), Iowa (1991), Kansas (1996), Louisiana (1993), Michigan (1993), Minnesota (1991), Mississippi (1992), Missouri (1994), Nebraska (1993), New Jersey (1978), New Mexico (1990), New York (1993), North Carolina (1995), North Dakota (1993), Oregon (1993), South Dakota (1989), Texas (1993), Washington (1992), Wisconsin (1991) and West Virginia (1994).

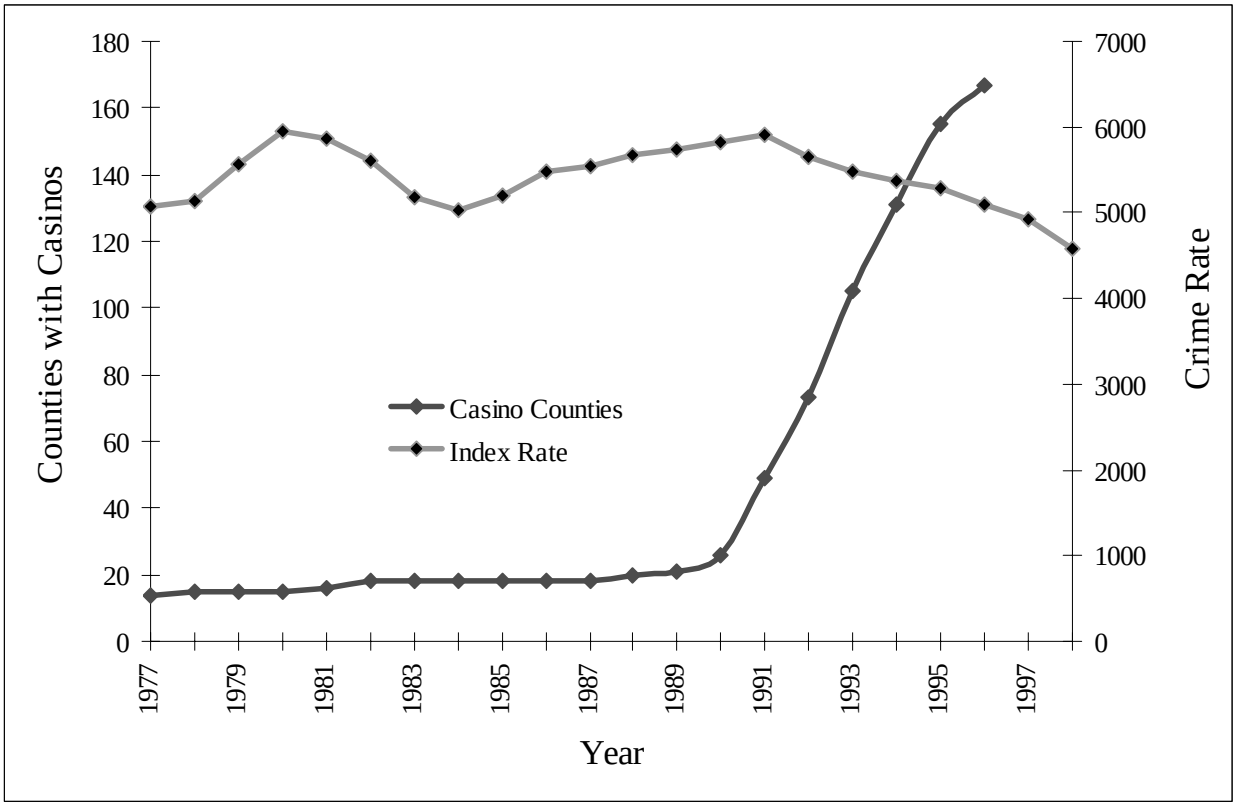
[7] The state legislature changed the Florida crime reporting process from summary-based to incident-based on Jan 1, 1988. In 1995 Florida switched back to summary-based reporting. In the transition years, data are missing.

Table 1: Demographic and Crime Data: Casino vs Noncasino Counties.

Variable	Mean	Std. Dev.	Sample Size	Mean	Std. Dev.	Sample Size
	CASINO COUNTIES			**NONCASINO COUNTIES**		
Population	148,319	293,792	3,313	73,310	252,150	59,273
Population Density (pop. per sq. mile)	208	501	3,313	217	1,459	59,265
Area (Square Miles)	2,060	3,132	3,313	1,010	2,880	59,280
Per capita Personal Income	$11,407	$2,657	3,313	$10,805	$2,619	59,260
Per capita Unemployment Ins.	$79	$55	3,313	$64	$51	59,244
Per capita Retirement Compensation	$10,787	$6,545	3,313	$9,833	$6,244	59,248
Aggravated Assault Rate	259	276	3,072	188	245	54,724
Rape Rate	29	27	3,009	20	32	54,055
Murder Rate	6	9	3,081	6	10	54,801
Larceny Rate	2,537	1,428	3,081	1,741	1,939	54,795
Burglary Rate	1,063	668	3,081	771	1,109	54,792
Robbery Rate	82	135	3,081	44	143	54,796
Auto Theft Rate	267	263	3,081	167	277	54,800

Note: Crime rates are annual number of incidents per 100,000 population.
Income figures are price-adjusted to 1982-84 $.

Figure 1: Index Crime Rate and Number of Counties with Casinos: U.S. 1977-1998

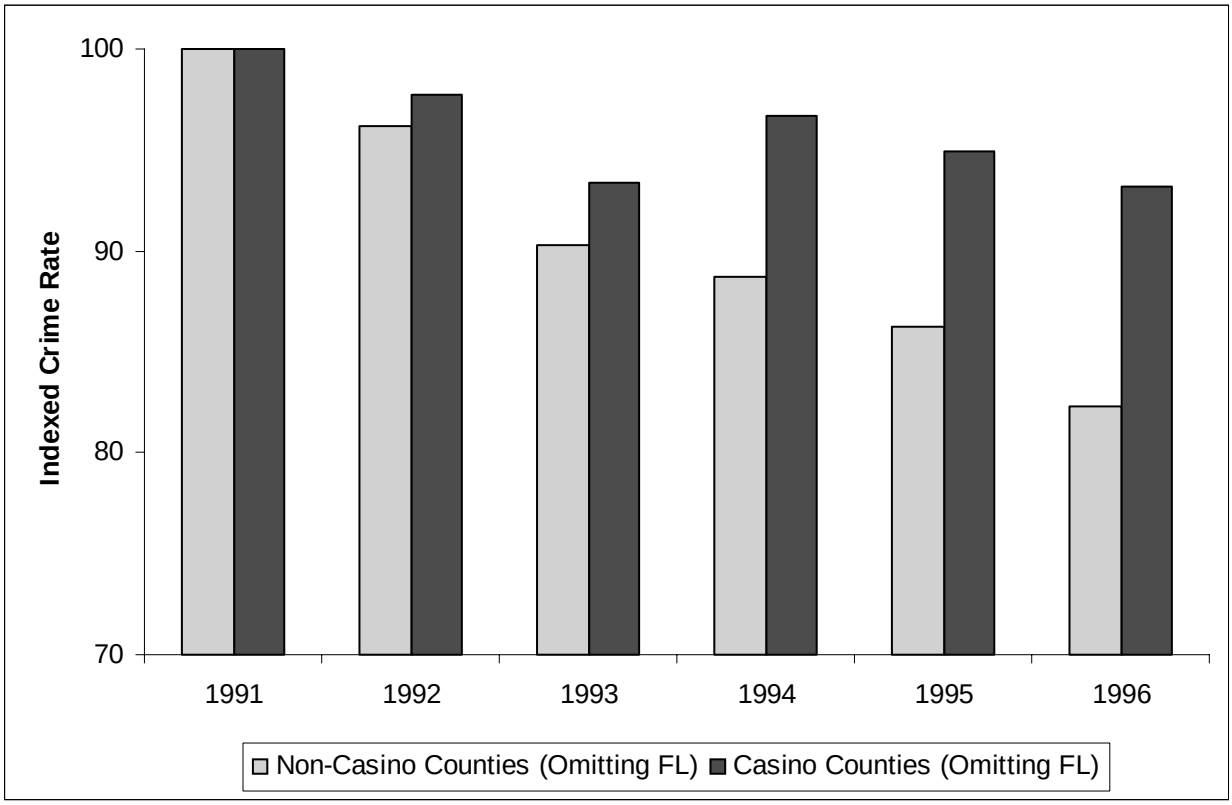


While crime dropped in both sets of counties, there was a widening divergence in the extent of the decline after 1991. If crime rates in casino counties had dropped in proportion to the drop in non-casino counties, crime in casino counties in 1996 would have been 11.7 percent lower. Far from suggesting that casinos lowered crime, falling crime rates in casino counties when compared to dropping crime rates everywhere, suggest that casinos may have been responsible for as much as 11.7 percent of the observed crime in such counties.

2. Florida

In addition to the need to consider Florida separately because of gaps in its data for two years of the sample, it is of interest in its own right because it is a large state and was the first state after New Jersey to acquire casinos. Florida's first "boat-to-nowhere" casino began operation in 1982. Other counties acquired casinos in 1988, and the early 1990s. Florida casino counties experienced greater rates of crime increase than the state's noncasino counties. Figure 3 highlights this differential for each of the crimes indexed so that 1982 = 100. The lower connected line forms a margin for 1977 showing the relative crime rate across all seven

Figure 2: Indexed Crimes: Casino County vs Noncasino County Crime Rates

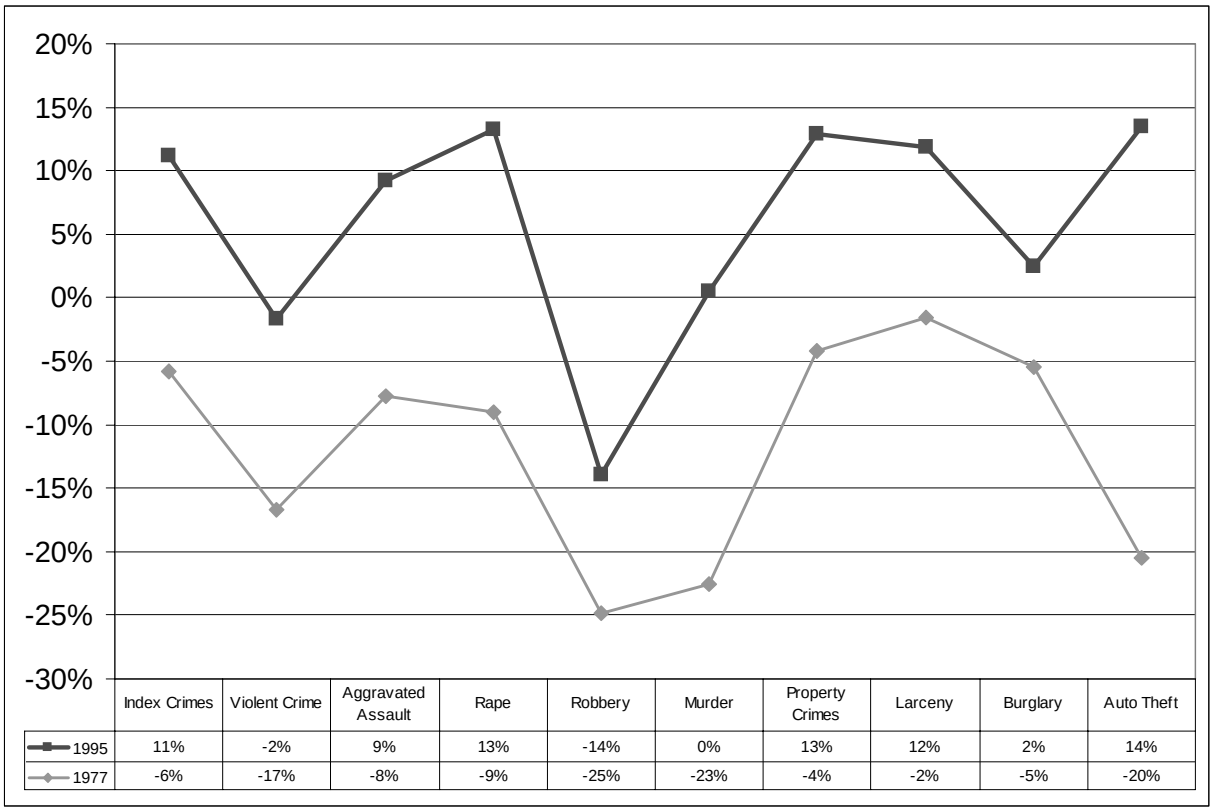


crime categories. The higher line shows that the 1995 margin rose. For example, the crime index in 1977 was 6 percent lower in casino than noncasino counties (this is the left-most Index Crime observation point on the lower margin). By 1995, however, it was 11 percent *higher* (the Index Crime observation on the higher margin). For every crime except robbery, casino counties had lower crime rates in 1977, and higher crime rates in 1995. The robbery rate in casino counties in 1977 was 25 percent lower than in noncasino counties; by 1995 it was only 14 percent lower.

3. American Indian Casinos

A similar pattern applies to American Indian casinos. Many states have American Indian casinos governed by state compacts negotiated under the Indian Gaming Regulatory Act of 1988. Most compacts were signed, and Indian casinos opened, after 1992. In some states (Connecticut, Minnesota, and Wisconsin are examples) Indian casinos are the sole type of casino. Figure 4 computes crime rates in Indian compact counties as a percent of the equivalent crime rate in noncompact counties for 1987 (the year before the Indian Gaming Regulatory Act was passed), in 1992 and 1996. Crime rates between 1987 and 1992, when casinos were just

Figure 3: Casino County Crime Rates as Percent Deviation from Noncasino County Rates: Florida 1977 and 1995.



	Index Crimes	Violent Crime	Aggravated Assault	Rape	Robbery	Murder	Property Crimes	Larceny	Burglary	Auto Theft
1995	11%	-2%	9%	13%	-14%	0%	13%	12%	2%	14%
1977	-6%	-17%	-8%	-9%	-25%	-23%	-4%	-2%	-5%	-20%

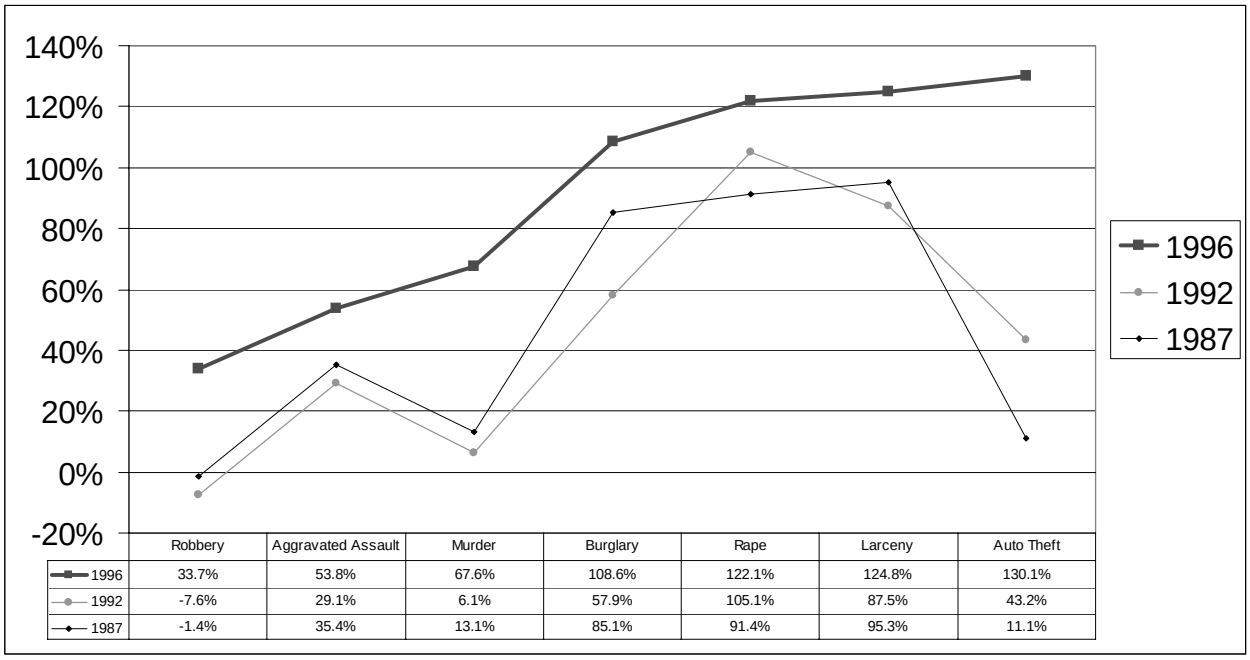
beginning or had not yet been introduced, changed little relative to other counties, but between 1992 and 1996, the period of greatest increase in compact casinos, crime in compact counties rose noticeably in all categories.

4. Evidence from Year of Opening

Figure 5 presents the casino county data centered on the year of opening, where we set the average crime rate for the four years prior to casino opening to 100. Crime rates were very stable prior to opening, slightly lower in the year of casino introduction, returned to approximately average levels for the next three years and increased thereafter. By the fifth to seventh year after introduction, aggravated assaults were 50 to 95 percent higher, robbery was 71 to 119 percent higher, larceny was 9 to 41 percent higher, and auto theft and burglary also showed increases. Only rape was approximately unchanged at 7 percent lower to 12 percent higher.

When grouped around the year of opening the data suggest a connection between casinos and higher

Figure 4: Indian Compact County Crime Rates as Percent Deviation from Noncompact County Rates.



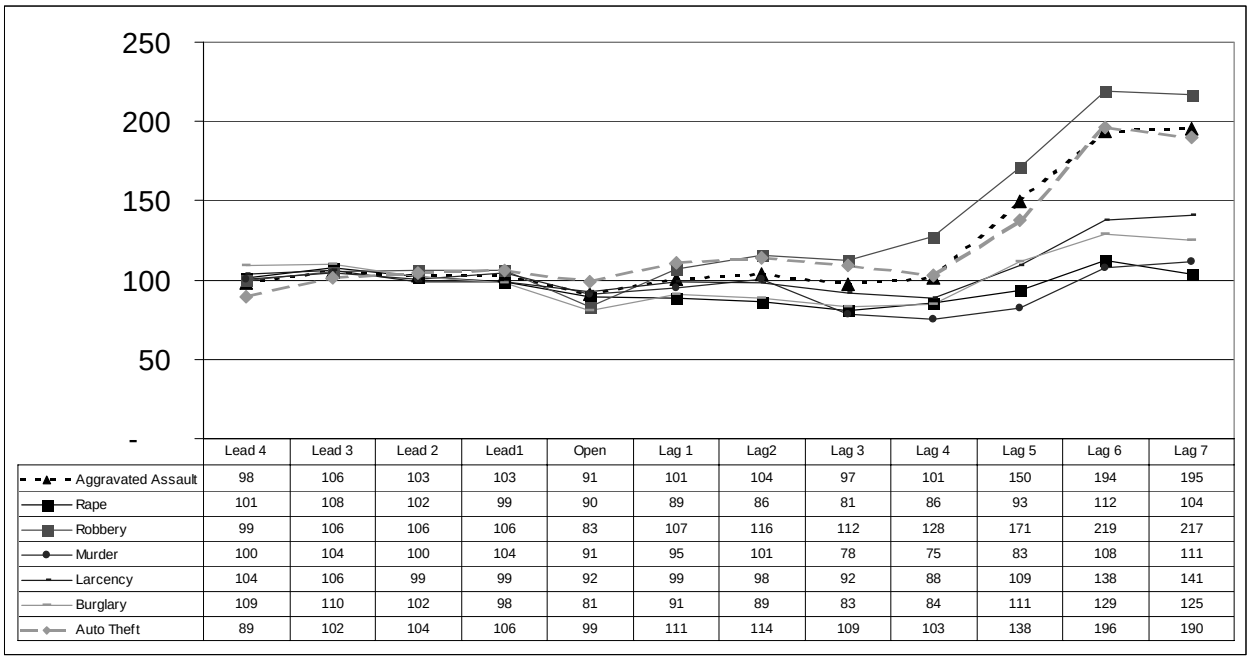
	Robbery	Aggravated Assault	Murder	Burglary	Rape	Larceny	Auto Theft
1996	33.7%	53.8%	67.6%	108.6%	122.1%	124.8%	130.1%
1992	-7.6%	29.1%	6.1%	57.9%	105.1%	87.5%	43.2%
1987	-1.4%	35.4%	13.1%	85.1%	91.4%	95.3%	11.1%

crime rates and the need to estimate lead and lag structures to correctly capture and identify the relevant time dependencies. The lead structure will show that crime rates in casino and non-casino counties were not different prior to the casino opening dates.

B. Existing Studies: A Critique

In spite of much public attention devoted to casinos and the many important questions surrounding this dynamic sector, there is a paucity of convincing research on the casino-crime link. Economists, virtually silent about the issue, are just beginning to research this new area. Studies from other disciplines, which typically compare crime rates of different cities or regions in a given year, exhibit many fundamental weaknesses. For example, no study examined the intertemporal effect of casinos on crime, which we argue is essential to understanding the relationship. In addition, nearly every study used small samples, most frequently focused on Las Vegas, Atlantic City or Reno. Many of these studies reach conflicting conclusions. Albanese (1985, 1999) examined areas around Atlantic City, arguing that New Jersey's Crime Casino Act (1977) minimized the increase in crime, and later studied only nine large casino markets. Lee and Chelius (1989) concluded that the New Jersey Casino Control Commission kept Atlantic City casino ownership and management free from organized crime. In contrast, organized crime played a large role in the casino labor unions. Friedman, Hakim and Weinblatt (1989) studied 64 localities near Atlantic City with populations over 1000. They found

Figure 5: Crime Rates Before and After Casino Opening - All Casino Counties Except Florida



	Lead 4	Lead 3	Lead 2	Lead1	Open	Lag 1	Lag2	Lag 3	Lag 4	Lag 5	Lag 6	Lag 7
Aggravated Assault	98	106	103	103	91	101	104	97	101	150	194	195
Rape	101	108	102	99	90	89	86	81	86	93	112	104
Robbery	99	106	106	106	83	107	116	112	128	171	219	217
Murder	100	104	100	104	91	95	101	78	75	83	108	111
Larcency	104	106	99	99	92	99	98	92	88	109	138	141
Burglary	109	110	102	98	81	91	89	83	84	111	129	125
Auto Theft	89	102	104	106	99	111	114	109	103	138	196	190

that casinos increased violent crimes, burglary and auto theft. Buck, Hakim and Spiegel (1991) also reported that Atlantic City gambling increased crime rates. Chiricos (1994), in contrast, reported that the cities with legalized gambling (Atlantic City, Las Vegas, and Reno) had lower crime rates than selected Florida tourist cities if one included visitors in the population base. Thompson, Gazel, and Rickman (1996a) studied statewide county-level panel data from Wisconsin and found that casino gambling significantly increased crime rates in counties with casinos and those with casinos in two adjacent counties.

Although some of the studies also made conclusions about crime rates, they examined arrests, and did not mention that one cannot use arrest rates to infer anything definitive about crime rates. Using arrest data, Albanese (1999) concluded that casinos did not increase embezzlement, fraud and forgery crime rates. Hsing (1996) used a cross-section of 48 states and identified higher illegal drug arrests in states that permit gambling.

A fourth criticism is that most studies are subject to substantial omitted variable bias because they rarely controlled for variables that affect crime. Margolis (1997), Florida Department of Law Enforcement (1994), and Florida Sheriffs Association (1994) included no control variables.

Last, many studies were agenda-driven, conducted or funded by either pro-gambling or law enforcement organizations. Nelson, Erickson and Langan (1996), Margolis (1997) and Albanese (1999) were funded by explicitly pro-gambling groups. Not unexpectedly, they concluded that gambling had no impact on crime.[8]

[8]See Wheeler (1999) for an interesting discussion of research funded by the gambling industry.

Margolis (1997) focused on Las Vegas, Atlantic City, Reno, and Deadwood, SD. The Florida Department of Law Enforcement (1994) and Florida Sheriffs Association (1994), who both opposed casinos, concluded that crime and drunk driving increased in Atlantic City and Gulfport, Mississippi, as a result of casinos.

In summarizing the existing body of literature, the GAO and National Gambling Impact Study Commission (NGISC) concluded that no definitive conclusions can yet be made about the casino-crime link because of the absence of quality research. According to the GAO, "In general, existing data were not sufficient to quantify or define the relationship between gambling and crime... although numerous studies have explored the relationship between gambling and crime, the reliability of many of these studies is questionable." (GAO, 2000, p. 35.)

II. Theory

Previous studies focused on the empirical question of whether there is a connection between casinos and crime but neglected precise discussions of how casinos theoretically could affect crime. We present two reasons why crime could decrease and four reasons why crime could increase. We then discuss their different impacts over time, an essential, but previously ignored issue.

A. Theoretical Connections between Casinos and Crime

Casinos may reduce crime directly by improving legal earning opportunities or indirectly through economic development effects.

1. Wage Effects: Grogger (1997) argued that increases in wages reduce crime, and Gould, Mustard and Weinberg (1998) showed that increases in employment and wages of low-skilled individuals reduce crime. Therefore, if casinos provide greater labor market opportunities to low-skilled workers, they should lower crime.

2. Economic Development: Casinos may also reduce crime indirectly through economic development. In the Midwest, for example, legislation decriminalizing casino gambling cited economic development as its rationale. Decaying waterfronts and derelict sections of town that once harbored crime may be less amenable to it when renovation occurs, streetlights appear, and resident presence increases. The streets near Las Vegas casinos, even at night, are often cited as some of the safest.

Conversely, casinos may increase crime through direct and indirect channels.

1. Economic Development: Casinos may raise crime by harming economic development, the opposite of the indirect effect discussed above. While some commend casinos for bringing development, others criticize them for draining the local economy, attracting unsavory clients, and for outgrowths like prostitution and illegal gambling-related activities.

2. Increased Payoff to Crime: Second, casinos may increase crime by lowering the information costs and increasing the potential benefits of illegal activity. Because casinos attract gamblers and money, there is an increased payoff to crime from a higher concentration of cash and potential victims. A 1996 Kansas

City case is illustrative in which a local restaurant owner was followed home, robbed, and murdered in his garage after winning $3,000 at a casino.[9] Similar stories exist in other locations with casinos.

3. Problem and Pathological Gambling: Crime may increase through problem and pathological gamblers. Pathological gambling is a recognized impulse control disorder of the Diagnostic and Statistical Manual (DSM-IV) of the American Psychiatric Association. Pathological gamblers (often referred to as "addicted" or "compulsive" gamblers) are identified by repeated failures to resist the urge to gamble, reliance on others to relieve the desperate financial situations caused by gambling, the commission of illegal acts to finance gambling, and the loss of control over their personal lives and employment. Problem gamblers have similar problems, but to a lesser degree. The latent propensity to pathology becomes overt when the opportunity to gamble is provided and sufficient time has elapsed for the problem to manifest. Lesieur (1998) estimated that pathological gamblers are one or two percent of the population and problem gamblers are another two to three percent. A well-cited Maryland study found that 62 percent of the Gamblers Anonymous group studied committed illegal acts as a result of their gambling.[10] 80 percent had committed civil offenses and 23 percent were charged with criminal offenses. A similar survey of nearly 400 members of Gambler's Anonymous showed that 57 percent admitted stealing to finance their gambling. On average they stole $135,000, for a total of over $30 million.[11]

4. Visitor Criminality: Crime may rise because casinos attract visitors who are both more prone to commit and be victims of crime. For example, Chesney-Lind and Lind (1986) suggest that one of the reasons tourist areas often haver more crime is that tourists themselves are the targets of crime. However, visitors *per se* do not necessarily increase crime. In the following section we show that visitors to national parks do not increase crime. Therefore, if casino visitors induce crime, it is because they are systematically different than national park visitors or visitors to other attractions.[12] Also, more problem and pathological gamblers will visit casinos than other attractions. One anecdotal example of the different clientele casinos attract is the large increases in pawnshops that occur when casinos open. Other tourist areas do not experience similar increases.

These mechanisms should have different impacts across crimes. Improvements in the legal sector, for example, reduce property crime more than violent crime (Gould, Mustard and Weinberg, 1998). If casinos

[9]Reno, 1997.

[10]See Maryland Department of Health and Mental Hygiene (1990).

[11]Henry Lesieur from the Institute of Problem Gambling, in testimony before the National Gambling Impact Study Commission, Atlantic City, New Jersey (January 22, 1998).

[12]The three largest single tourist attractions in the Unites States in 1994 were the Mall of America (Bloomington, MN), Disney World (Orlando, Florida), and Branson, Missouri (country and western music) receiving 38 million, 34 million, and 5.6 million visitors, respectively. For comparison, Hawaii received approximately 6 million and Las Vegas received 30.3 million visitors in 1994. Visitors per resident were 1,345 for Branson, 436 for Bloomington, MN, 188 for Orlando, and 40 for Las Vegas. Even combining visitors with residents to calculate diluted crime rates, the crime rate per 100,000 visitors plus residents was 187.3 for Las Vegas, 64 for Orlando, 16.4 for Branson, and 11.9 for Bloomington. Thus Bloomington which recieved 7.7 million more visitors than Las Vegas had a crime rate per visitor plus resident less than $\frac{1}{15}$th of the rate for Las Vegas.

act as magnets for unsavory development then all types of crime may increase. Pathological gamblers will generally commit crime to generate money to pay off debts or gamble.[13] Therefore, they would be more likely to commit crimes that generate revenue, like robbery, burglary, larceny and auto theft. Furthermore, if casinos increase criminal activity by problem and pathological gamblers, this increase could be compounded by spillover effects on others (Glaeser, Sacerdote, and Scheinkman, 1996).

The theory also predicts that the effects of casinos will change over time. Reduction of crime through improvements in labor market opportunities will be observed prior to the casino opening. Because casinos take time to build, and low-skilled people may be hired before casino openings, crime reductions could precede the openings. Both the positive and negative economic development theories imply that a casino will have an impact after opening. Over time, the development effects will grow, whether positive or negative. The nonresident effect should appear with the casino's opening, but may also expand with time as more nonresidents are attracted. Effects operating through problem and pathological gamblers will not be felt for the first few years. Enough time must elapse for a gambling habit to develop and the full extent of gambling pathology to be reached. Because crime data are reported annually and casinos could open in a given year as late as December, there may not be a discernible effect on crime rates until several years after they open.

III. Estimation Strategy

Our strategy is to address the identified research gap by rectifying a number of research limitations. First, we conduct the most exhaustive investigation to date, utilizing a comprehensive county-level crime data set that includes every U.S. county. This eliminates sampling concerns. Second, we analyze crime effects over time by exploiting the time-series nature of our data, which cover 1977 through 1996. Third, we do not focus on one or two crimes, but examine all seven FBI Index I Offenses (aggravated assault, rape, murder, robbery, larceny, burglary, and auto theft). The first four offenses are classified as violent crimes and the last three as property crimes. Fourth, we are the first to explicitly articulate a comprehensive theory about how casinos could increase and decrease crime.[14] Last, we use the most exhaustive set of control variables, most of which are commonly excluded from other studies. If casinos are correlated with these excluded variables, then previous estimates will suffer omitted variable bias. We conclude that casinos increase crime in their host counties and that crime spills over into neighboring counties to increase crime in border areas.

A. Direct and Indirect Effects

Casinos can affect crime rates directly through effects on the resident local population and indirectly by increasing the number of casino visitors. The total impact includes both direct and indirect effects, as explained in equations (1) and (2), where crime (C_{it}) in county i in year t is a function of the presence of a

[13]Continued gambling is often perceived as a way to win back needed money. "Chasing" one's losses is a characteristic of pathological gamblers.

[14]Miller and Schwartz (1998) explained in detail how the literature has generally neglected discussing the theoretical links between casinos and crime.

casino, the number of casino visitors (V) to the county, and other variables that affect crime (summarized in the term *Other*) where a, b, c, and d are unknown coefficients.

$$C_{it} = aCasino_{it} + bV_{it} + Other_{it} \quad (1)$$

$$V_{it} = cAttractions_i + dCasino_{it} \quad (2)$$

Casino visitors in equation (2) depend both on the visitor attractiveness of the county (*Attractions*) and the presence of the casino. Coefficient a measures the direct effect of the casino on crime. The indirect effect via casino visitors is measured through coefficients b and d. Substituting from (2) into (1) gives

$$C_{it} = \beta_i + \delta Casino_{it} + Other_{it} \quad (3)$$

where $\delta = a + bd$, and $\beta_i = bc\, Attractions_i$. The total effect of the casino on crime, δ, in equation (3), includes the effects on both the local population and casino visitors. Estimating a in (1) would give only a partial effect because it would not take into account the visitor effect.[15] The key to our being able to estimate the full effect is having time series data. Because many studies of the casino-crime relationship used cross-sectional data, they were limited to estimating only a partial effect.

B. Visitors

Estimating direct and indirect effects is important. At the same time, it is also important to avoid a related misperception. The observation is sometimes made, "X is associated with crime increases because X increases tourism and tourists cause crime." From there the inferential leap is made that any attraction that attracts the same number of visitors will have the same crime effects. This perception is false. Apart from begging the empirical question of whether it is uniformly true that tourists cause crime, this conclusion comes perilously close to ignoring the equally important fact that visitors are not generic. Systematically different types of visitors may have systematically different effects on crime even if the impact for all types of visitors is positive. The presence of a casino in (3) proxies for direct effects on crime that may exist and for an increased number of casino visitors. It does not necessarily follow that the same number of visitors for another purpose would lead to the same crime outcomes. Visitors for other purposes appear in the variable $Other_{it}$, which we now address.

Time series visitor data do not exist at the county level and certainly do not distinguish visitors for different purposes. Running regression (3) without such information, therefore, risks a potential omitted variable bias. In defense, no other crime studies have been run with these data either, but more importantly, in the case of casinos, the omitted variables are almost certainly uncorrelated with the entry of a casino.

[15] Ideally we would like to know both a and b to decompose the total effect into the portions generated by visitors and by locals. Because of data constraints, we estimate the total effect d but not a and b separately. Casino visitor data do not exist at the county level. Both a and b might be estimated using other variables to proxy for the number of casino visitors, but there are no annual, time-series data at the county level.

Fortunately, there is at least one type of tourist for which data *are* available that we can use to test the hypothesis of being uncorrelated and having an effect on crime different from the effect that casinos have. For this we obtained National Park Service time series data from 1978 to 1998 on all visitors to national parks, monuments, historic sites, recreation areas and so on. Scores of these parks and attractions, scattered all across the country, receive millions of visitors annually—some as many as 14 million. They are in counties both with sparse population and in counties with large cities. If vacationing families cause crime to the same extent as other visitors, then these counties should have crime rates to match. In the majority of cases the correlation between park visitors and the casino variables used in the study were well below 1 percent and in no case was the correlation above 1.7 percent. This is consistent with the view that omitted variable bias is likely to be small or zero. Although it always preferable to include such variables when possible, we are confident that in the case of casinos the procedure employed by (3) of, in effect, treating data on other visitors as part of the constant term and the error term is not a problem for the coefficients of interest.[16]

A second analytical issue is whether to use "diluted" or "undiluted" crime rates. That is, should the number of crimes be divided by population—the conventional way to generate the crime rate (undiluted)—or be divided by population *plus* visitors (diluted)? There are four possibilities for research depending on whether one considers total or partial effects, and studies diluted or undiluted crime rates. Some have argued for one combination or another without realizing that the choice is not methodological, but depends on what questions the researcher wants to answer. A frequently mentioned invalid claim is that to determine the change in probability that a resident would be the victim of a crime, the diluted crime rate should be used. However, knowing what happens to the diluted crime rate does not give the needed information and could even move in the wrong direction. Let s_1 be the share of the resident population P victimized by residents, and let s_2 be the share of the resident population victimized by visitors V. Similarly, let σ_1 be the share of visitors victimized by residents, and σ_2 the share of visitors victimized by visitors. Then the crime rate is $s_1 + s_2 + (\sigma_1 + \sigma_2)\frac{V}{P}$; the diluted crime rate is $(s_1 + s_2)w_P + (\sigma_1 + \sigma_2)w_V$ where w_P and w_V are the share of visitors plus residents made up by residents and visitors, respectively; and the probability of a resident being a crime victim is $s_1 + s_2$. For example, assume that residents do not victimize visitors ($\sigma_1 = 0$), $P = V$, and $(s_2 + \sigma_2)$ is smaller than s_1. Without visitors the probability of a resident being victimized is s_1. With visitors it rises to $s_1 + s_2$. The diluted crime rate without visitors is s_1. With visitors it falls

[16]When visitors to National Park Service sites were included, the regressions (3) showed that an additional one million park visitors annually were associated with 1.4, 0.34, 14.8, 0.64, 5.5, and 1.73 fewer crime incidents per 100,000 population for aggravated assault, rape, robbery, murder, burglary, and auto theft, respectively. The coefficients for rape and murder were significant at the 5 percent level and the coefficient for robbery was significant at the 1 percent level. The estimated effect of an additional million visitors was 13 additional larcenies per 100,000 population, but this coefficient was statistically insignificant. Since we do not have casino visitor data to estimate coefficient b in (1) we cannot directly compare casino visitors' and park visitors' effects on crime rates. However, the size of the effect found for park visitors was many times smaller than the total crime effect found for casinos (coefficient δ) and reported in section IV. Depending on the crime, the effect of a casino on crime rates five years after entering a county was 7 to 170 times larger except for the crime of murder. Neither casinos nor park visitors appear to have an important effect on murder rates. Their coefficients were of comparable magnitude.

to $(s_1 + s_2 + \sigma_2)/2$. Thus in this case the diluted crime rate *falls* while the probability of a resident being victimized *rises*.

In this study we are interested in the costs in the host county associated with a change in crime from whatever source. We are therefore interested in the total effect of casinos on crime using the undiluted crime rate based on equation (3).

C. Separating Casino Effects from Other Effects and Timing

The version of equation (3) we estimated was

$$C_{it} = \alpha + \beta_i + \gamma_t + \delta L_{it} + \theta A_{it} + \varepsilon_{it} \tag{4}$$

where C_{it} is the crime rate (offenses per 100,000 people) of county i in year t, α is a constant, and β_i is the county-level fixed effect that controls for unobserved characteristics across counties. The time fixed effect, γ_t, controls for national crime rate trends. L_{it} is a 12×1 vector of the casino opening dummy. It includies 4 leads and 7 lags of the opening variable, and captures the intertemporal effects outlined earlier.

A_{it} is a vector of control variables. It includes population density, the percent of the population that was male, percent that was black, percent that was white, and the percent between the ages of 10-19, 20-29, 30-39, 40-49, 50-64, and over 65.[17] Economic variables in A_{it} are real per capita personal income,[18] real per capita unemployment insurance payments, real per capita retirement compensation per old person, and real per capita income maintenance payments. A_{it} also includes a dummy variable indicating whether the county honored a "shall issue" right giving citizens the authority to carry a concealed firearm upon request, and two years of leads and four years of lags on the shall issue dummy. A_{it} contains 22 explanatory variables. ε_{it} is the regression error. Including leads and lags, the regression has 54 explanatory variables. This was expanded to 66 when analyzing the effects of casinos on adjacent counties. Excluding observations with missing data reduced the sample size in most regressions from 63,300 $(3,165 \times 20)$ to about 58,000, leaving more than adequate degrees of freedom for estimation.

The effect of a casino on crime depends on δ. A positive coefficient δ indicates that the introduction of casinos increased crime and a negative coefficient indicates that it reduced crime. We independently estimated each lead and lag of the casino opening year without cross restrictions to give separate estimates of the timing of changes. We weighted observations in the regression by county population.

[17] The remaining groups were Hispanics and those between 0 and 9 years.

[18] This and all other income figures were adjusted to 1982-84 $ base.

D. Data Preparation

1. Crime Statistics and Control Variables

The sample covered 3,165 U.S. counties from 1977-96. The Federal Bureau of Investigation's Uniform Crime Report[19] provided the number of arrests and offenses for the 7 FBI Index I offenses.[20] With the exception of Alaska, the county jurisdictions usually remained unchanged over our sample period. We used U.S. Census Bureau data for the demographic characteristics that might affect the crime rate. These controls include population density per square mile, total county population, and population distributions by race, age and sex. Income, unemployment, income maintenance transfers, and retirement data were obtained from the Regional Economic Information System, a component of the Bureau of Commerce. Appendix II provides more information about the data.

2. Casino Locations

The natural operating measure for casinos is gross revenue or profits. Unfortunately, such panel data do not exist—American Indian casinos are not required to report revenues. We therefore used the year a county first had an operating Class III gambling establishment, including riverboat casinos, American Indian casinos, land-based casinos, and in the case of Florida and Georgia, "boats to nowhere"—cruises that travel outside U.S. boundary waters to gamble, and that contain primarily U.S. participants. Not all forms of gambling qualify as a casino. For example, Montana has thousands of small gambling outlets that offer keno or video poker, many of which are in gas stations along the highway. Also, California has many card houses, some of which are illegal. These establishments are distinct from casinos in size and type of play.

We first contacted state gaming authorities. In cases like Washington, this was an expeditious way to ascertain the first year a casino opened. However, even the central gaming authorities and Indian affairs committees often lacked information on Indian casinos. In most states, therefore, we called each casino to obtain its opening date or first date of Class III gambling if it had previously been a bingo hall, etc. We also used lists from the Casino City website, www.casinocity.com, which lists casinos in every state. This list was verified against the annually-produced *Executive's Guide to North American Casinos*.

IV. Results

Table 2 reports the results for the coefficients of interest: four years of leads, the opening, and seven years of lags of the casino opening variable.[21] t-statistics are shown below the estimated coefficients. All coefficients

[19] U.S. Department of Justice, Federal Bureau of Investigation. *Uniform Crime Reports: County-level Detailed Arrest and Offenses Data, 1977-1996.* Washington, D.C.: U.S. Department of Justice, Federal Bureau of Investigation. Ann Arbor, MI: Inter-university Consortium for Political and Social Research (distributor).

[20] See Appendix I for the definitions of the crimes.

[21] The results for the 588 other coefficients and t-statistics for the seven crime regressions are not included in the interest of space, and because they are used as controls and we are primarily interested in the casino-related variables.

refer to changes per 100,000 people. For example, the coefficient of Lag 4 in the column labeled "Aggravated Assault" is 50.29 and indicates that the aggravated assault rate was higher by 50.29 offenses per 100,000 population four years after a casino opened in the county. The number of observations for each regression varied from 57,029 to 57,847. R^2 was between .70 and .89.

The reported regressions exclude measures of law enforcement activity such as conviction rates, sentence lengths, arrest rates, annual police employment and law enforcement expenditures for two reasons. First, including them would have significantly limited the number of counties with available data. Conviction rates and sentence lengths are available for only four states (Mustard 2000), and annual police employment is unavailable at the county-level. The trade-off was one of reduced efficiency from loss of data versus omitted variable bias that would lead us to understate the true impact of casinos on crime.

Using the arrest rate is problematic because it is undefined when there are 0 offenses for a given crime type.[22] Many small counties in our sample record no offenses even for property crimes for a given year, and large counties frequently have no offenses for murder and rape. Therefore, including the arrest rate eliminated many observations, reducing our sample by over 30,000 observations for some offenses.

Second, and more important, by excluding these variables the reported regressions understate the true impact of casinos on crime. The Table 2 regressions with the arrest rate included displayed increased post-opening casino coefficients.[23] This is consistent with information from law enforcement officials who reported that enforcement expenditures increased substantially when casinos opened, and provides support for the evidence that omitting these variables understates the crime effect. Stephen Silvern (FBI in Atlantic City) documented that expenditures for the Atlantic City Police Department and Prosecutor's Office grew much more rapidly in the late 70s and early 80s than similar expenditures in the rest of the state and nation (Gaming Conference 1999). The Director of the Indiana Gambling Commission reported that Indiana hired an additional 120 state troopers when the casinos opened in 1995.[24] Allocations for police services also rose substantially in New Orleans upon introduction of casinos.[25] Law enforcement officials strongly emphasize that to maintain public safety it is necessary to increase spending on enforcement resources when casinos open. Because we are unable to accurately measure these additional resources that reduce crime, the estimates without law enforcement variables understate the effect of casinos on crime and form a lower bound on the impact.

The full regression output is available from the authors on request.

[22] See Lott and Mustard (1997) and Levitt (1998) for more detailed discussions of problems with arrest rates.

[23] We do not present the coefficients in a table because the results are qualitatively similar to the Table 2.

[24] John Thar, Director of the Indiana Gambling Commission, report at Gaming Conference 1999.

[25] Lt. Joseph P. Lopinto, Jr., Commander of the Gambling Section of the New Orleans Police Department reported that his department has been significantly resource constrained since the opening of New Orleans' casinos and the resulting increase in demand for police services. Gaming Conference 1999.

Table 2: Crime Rate Regressions - Casino Leads and Lags. .

(Coefficient units are additional crime incidents annually per 100,000 population.)

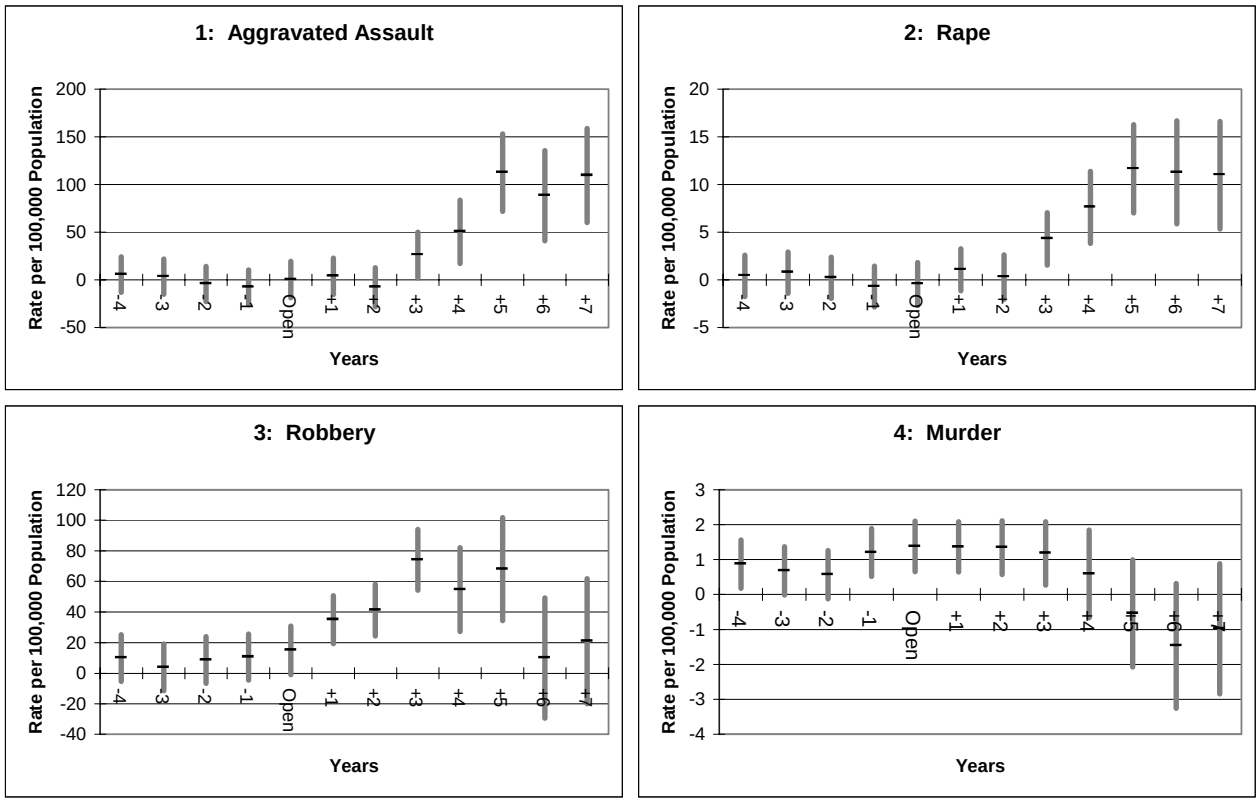
	Aggravated Assault	Rape	Murder	Larceny	Burglary	Robbery	Auto Theft
Lead 4	5.44	0.42	0.87	243.89	36.68	9.91	26.40
	(0.758)	(0.500)	(3.225)	(6.113)	(1.399)	(1.672)	(2.222)
Lead 3	3.14	0.76	0.68	200.61	34.09	3.79	74.62
	(0.438)	(0.902)	(2.506)	(5.031)	(1.301)	(0.640)	(6.286)
Lead 2	−4.32	0.21	0.57	89.83	19.43	8.67	117.84
	(−0.602)	(0.251)	(2.098)	(2.250)	(0.741)	(1.462)	(9.916)
Lead 1	−8.02	−0.72	1.20	88.05	−0.54	10.51	137.59
	(−1.132)	(−0.865)	(4.513)	(2.236)	(−0.021)	(1.796)	(11.735)
Open	0.25	−0.46	1.38	172.08	−17.60	14.94	177.33
	(0.033)	(−0.529)	(4.901)	(4.138)	(−0.644)	(2.418)	(14.323)
Lag 1	3.75	1.06	1.36	235.81	40.84	34.96	210.29
	(0.505)	(1.240)	(4.876)	(5.719)	(1.508)	(5.706)	(17.131)
Lag 2	−7.86	0.29	1.34	67.04	−41.24	41.18	189.68
	(− 0.988)	(0.316)	(4.486)	(1.516)	(−1.42)	(6.266)	(14.407)
Lag 3	25.81	4.30	1.18	99.52	−31.12	74.06	242.09
	(2.758)	(4.044)	(3.362)	(1.914)	(−0.911)	(9.586)	(15.641)
Lag 4	50.29	7.61	0.59	289.82	83.67	54.65	198.85
	(3.881)	(5.179)	(1.216)	(4.030)	(1.771)	(5.113)	(9.287)
Lag 5	112.55	11.64	−0.54	771.74	356.68	68.07	331.08
	(7.132)	(6.470)	(−0.909)	(8.775)	(6.173)	(5.208)	(12.645)
Lag 6	88.28	11.26	−1.47	777.38	201.59	9.99	359.71
	(4.790)	(5.364)	(−2.117)	(7.568)	(2.988)	(0.655)	(11.763)
Lag 7	109.50	10.98	−0.98	1092.90	226.56	20.91	377.81
	(5.704)	(5.021)	(−1.351)	(10.214)	(3.223)	(1.315)	(11.861)
N	57761	57029	57847	57841	57838	57842	57846
F	364.9	121	83.01	138.34	352.27	132.76	327.45
Prob > F	0.0	0.0	0.0	0.0	0.0	0.0	0.0
R-squared	0.825	0.741	0.762	0.800	0.697	0.891	0.851

A. Violent Crime

Figure 6 displays the information for violent crime from Table 2. The horizontal axis plots the casino opening leads and lags and the vertical axis plots the coefficient estimates. Figure 6.1, for example, shows the effect of casino opening on aggravated assaults for the four years before and seven years after opening. The plotted vertical lines show the 99 percent confidence intervals, the range within which the regression indicates the true coefficient should lie with 99 percent probability.

For aggravated assault, the coefficients for all four years of leads, the year of opening, and the first two years after the casino opening are not significantly different from zero. However, coefficients for the third and subsequent year after opening are significantly above zero, and the trend rises. By the third and subsequent year casinos are a statistically significant contributor to increased assault rates. The estimated high occurs

Figure 6: Casino Effects - Violent Crime



in the fifth year after opening, when the aggravated assault rate is 112 assaults higher per year.[26]

Although the point estimates for years 3 through 7 after opening are each statistically significant at better than the 1 percent level, the number of counties with casinos open three to seven years is 91, 59, 35, 12, and 7, respectively. Because the number of counties whose casinos opened 6 and 7 years before is small, we treat the estimates for the sixth and seventh year lags cautiously.

The problem of small number of observations should not be confused with the problem of poor observations from which we do not think the sample suffers for several reasons. First, counties that introduced casinos during the sample period and that remained open 7 or more years is geographically diverse, including Florida, Nevada, New Jersey, and South Dakota. Second, the dates of openings are temporally diverse, the earliest occurring in 1978, and others ranging up to eleven years later. During this time, national crime rates both rose and fell (see Figure 1). Third, there is no pattern to the crime rates in the diverse sampling of counties: 4 counties had a declining crime rate before casino introduction, 3 had rising, and the crime rates

[26]The estimated pattern of crime increase is unlike the typical pattern of visitor increases after casino opening. Grinols and Omorov (1996) showed the number of visitors to Illinois casinos typically rises immediately after opening and reaches equilibrium levels after six months or fewer.

after the introduction of casinos—covering as they did different regions and different eras of time—did not fit any pattern. Fourth, the pattern observed in Figure 6 was robust to removing the observations of each state. Fifth, the regression itself controlled for a large number of demographic, income, and other variables that varied across the different counties and different time periods.

Figure 6.2 for rape shows a pattern similar to aggravated assault. Coefficients are not significantly different from 0 prior to the opening. However, they are positive and significant in the third year after the casino opened, and rise thereafter. A county that introduces a casino might expect a negligible impact in the first two years after opening, but a higher rape rate by 8 to 12 incidents per 100,000 population in the fourth and fifth years after opening. The pattern for robbery (Figure 6.3) is similar to aggravated assault and rape with two exceptions. First, the increase in robbery began immediately. Second, the estimated coefficients for the sixth and seventh years after the casino opened cannot be distinguished from zero. One potential explanation is that the effect of casinos on robbery dies out in the sixth and seventh years after opening. Another is that the sample does not have enough observations with casinos opening six or seven years previously to distinguish an effect for this type of crime.

As expected, the impact of casinos on murder is the smallest of all offenses. Figure 6.4 shows there are significant coefficients only for the year before opening through the third year after opening, and implies about 1.3 additional murders for casino counties. However, casino counties have slightly higher murder rates (by about 0.7) before opening, and the change from before to after is not statistically significant. Gambling-related murders and deaths are frequently high profile cases. They include cases such as the disgruntled gambler who killed a casino teller when he tried to retrieve his gambling losses, a spouse who fought over the other's gambling losses and was murdered, a parent's gambling leading to the death of a child and similar tales.[27] However, such murders are not frequent and systematic enough to merit a strong assertion about the impact of casinos on murder. Because murder is the least frequently committed crime and most counties have zero murders, murder rates typically have high variance, which makes it difficult to conclusively identify effects.

B. Property Crime

Figure 7 displays the Table 2 coefficients for property crimes, which are committed far more frequently than violent crimes. Figure 7.1 displays a pattern similar to rape, robbery and aggravated assault (Figures 6.1, 6.2, and 6.3)—relatively little impact until the fourth year when crime rates increase consistently. The larceny coefficients increase from 67 in the second year after opening to over 1000 by the seventh year. This

[27]See Jeffry Bloomberg, Prepared Statement, Hearing Before the Committee on Small Business, House of Representatives, 103rd Congress, Second Session, 21 September 1994, Serial No. 103-104, Washington, D.C.: USGPO, p. 47. Accounts of the more spectacular gambling-related murders and deaths (most often suicides) often appear in the press. *USA Weekend*, February 10-12, 1995, p. 20, for example, describes a man killing his wife and beating up his daughter in a fight over his gambling away thousands of dollars. The Associated Press September 3, 1997, reported on the 10-day-old infant who died of dehydration after being left in a warm car for about seven hours while her mother played video poker in South Carolina.

rising impact indicates that the negative effects of the casino-crime link outweigh positive impacts over time, and is consistent with the negative development argument that it takes a while for gamblers to exhaust personal resources before resorting to larcenous crime. An alternative explanation of the delayed impact is that casinos have an immediate impact on crime, but that impact is netted out by a large increase in police resources, which are typically significantly increased when casinos open, but do not maintain the same rate of growth over time. The slightly more immediate impact of casinos on violent crime observed in Figure 6 may be explained in terms of *imported* criminals. It may take less time to habituate to a new casino's location than for people to exhaust their resources.

Figure 7: Casino Effects - Property Crime

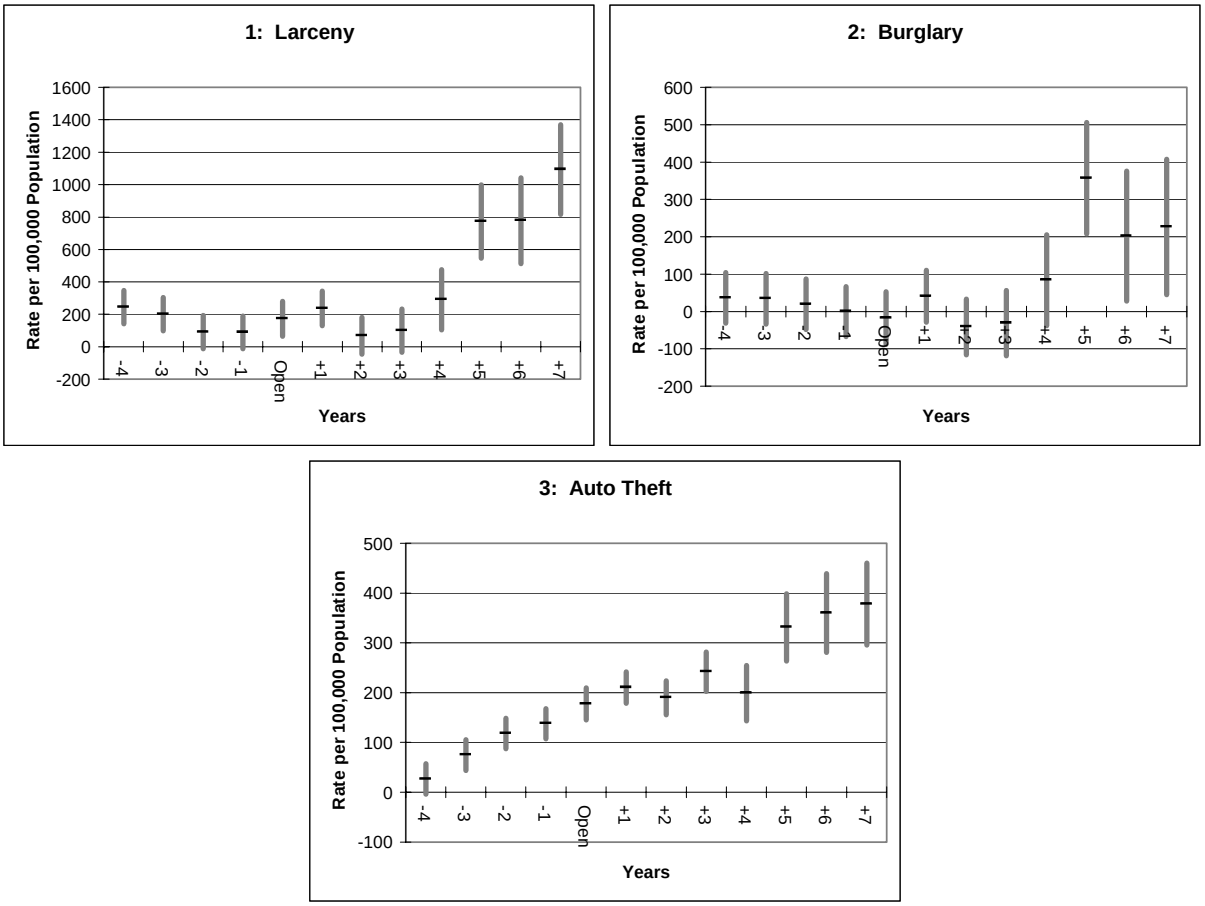
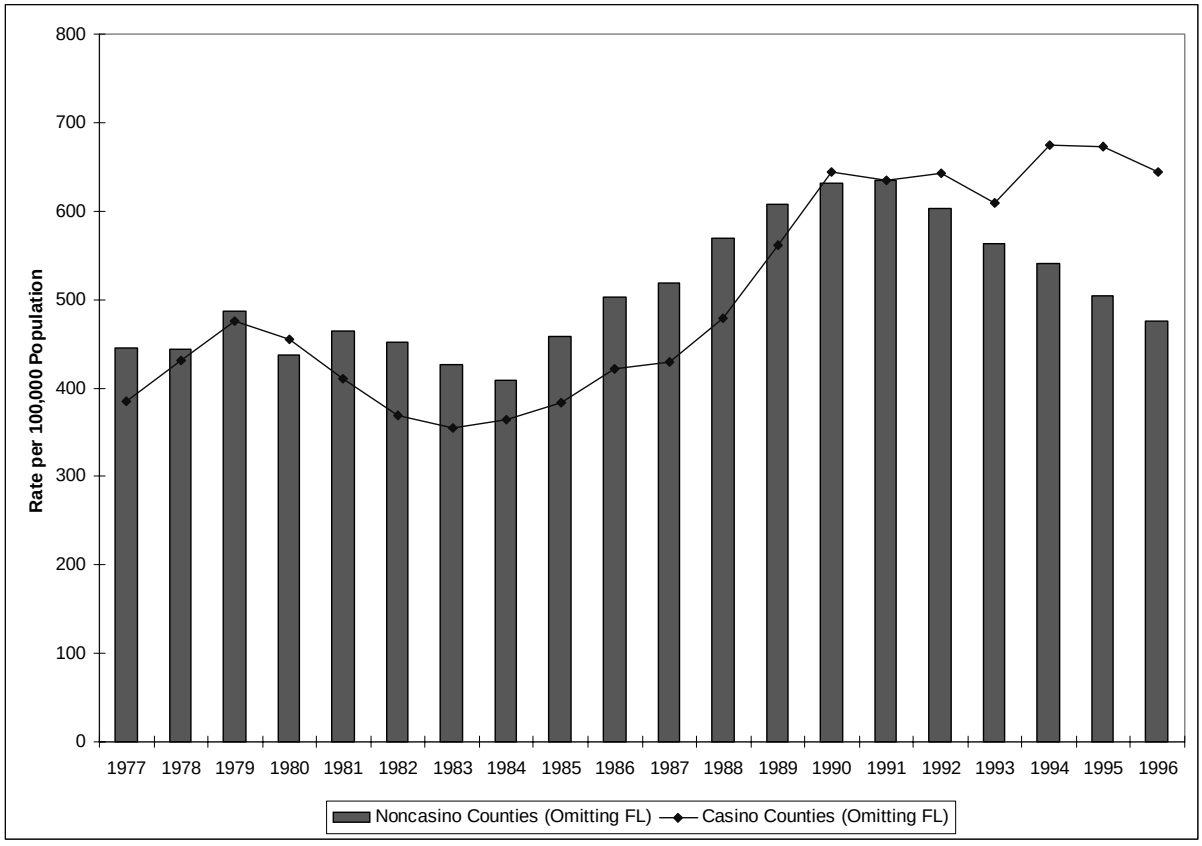


Figure 7.2 for burglary is very similar to larceny, robbery, assault and rape. Burglary shows no noticeable impact of casinos until the fourth year after casino opening. The five, six and seven year lag estimates are significant at between 200 and 400 additional offenses, again indicating that the negative effects of casinos dominate the positive effects over time.

Figure 7.3 for auto theft presents a different picture. It is the only crime that showed a rising trend before casino opening, which continued unabated through the seventh year after opening. Figure 8 shows that casino counties did not experience the same decreases in auto thefts that noncasino counties experienced after 1991, when the number of casinos increased rapidly.[28] Thus, one reason for the auto theft results is that casinos play a role in causing auto thefts not to fall as fast as they did in noncasino counties.

Figure 8: Auto Theft Crime Rates: Casino vs. Noncasino Counties



A second factor may be that we were unable to control for Lojack, an electronic tracking system that allows police to quickly locate and recover stolen autos. Ayres and Levitt (1998) found that Lojack accounted for a significant reduction in auto thefts in the 1990s. Because cities that implemented Lojack generally do not have casinos, we may overstate the effect of casinos on auto theft.[29] It is also possible that Lojack's use

[28]Note that a similar divergence in Florida started in 1984 and grew after that, consistent with Florida casino openings. The first Florida casinos opened in two counties in 1982, two more opened in 1988, and the rest opened between 1990 and 1995.

[29]Ayres and Levitt (1998) showed that Lojack had little effect on other offenses, so our results for the other crimes will not be affected.

is not yet sufficiently widespread to greatly affect our estimates.

To summarize our empirical results, the casino opening lead variables indicate that casino and noncasino counties have similar crime patterns prior to the opening of casinos. Casinos are not more likely to be placed in areas that have systematically different crime environments than other regions. After casinos open the crime trends differ: casino-county crime rates increase relative to the noncasino-county rates. The differences typically begin a few years after casino opening and increase over time. These characteristics are consistent with the predicted effects outlined in the theory. For example, we know that problem and pathological gamblers generate crime and, according to clinical research, take about two or three years to exhaust alternative resources before they commit crime. Furthermore, the most significant effects are for offenses where obtaining financial resources is the primary motivation of the crime. Not unexpectedly, the only crime that shows no effect is murder, which has the least clear relationship to casino gambling. Studies that did not have large data sets, a sufficient number of years of observations after casino opening, and that did not allow for the impact to change over time have missed these effects.

The evidence presented thus far suggests that casinos increased crime, but provides no information about whether casinos created crime or redistributed it from one area to another. We address this question next.

V. Do Casinos Create Crime or Attract It from Elsewhere?

The previous section provided strong evidence that the introduction of casinos is associated with an increase in crime rates in the host county beginning approximately three years subsequent to introduction. Grouping crime into property and violent categories, the estimates suggest that after six years, 8 percent of property crime and 10 percent of violent crime in casino counties is due to casinos.[30]

But do casinos create crime, or merely move it from other locations? In this section, we address this question by examining the crime rates of counties that border casino-counties. When casinos open, crime rates in neighboring counties could either decrease, remain the same, or increase. The first possibility supports the idea that casinos move crime from adjacent counties but do not create new crime. In the second case adjacent counties experience no change in crime, which indicates that total crime rises and that casinos create crime. The last possibility is that both host and neighbor counties experience increased crime rates, which indicates that casinos create crime that spills over into neighboring areas.

To implement a test strategy, we defined a set of neighbor lead, opening and lag variables, similar to the original set used in Table 2 for the host county. The "neighbor opening" variable took a value of 1 if a casino opened in an adjacent county in a given year. These twelve new variables increase the number of regressors to 66. The adjacent counties are the relevant unit of measurement for this purpose, because the vast majority of casino patrons come from the local region surrounding the casino. For example, in Illinois over 92 percent of casino customers come from within 75 miles.[31] Therefore, a substantial majority of the visitor movement will be accounted for with the adjacent county technique. A few casinos, most of which

[30]Section VI. explains the computation of these numbers.

[31]Gazel and Thompson, 1996.

Table 3: Crime Rate Regressions - Casino Neighbor Leads and Lags

	Aggravated Assault	Rape	Murder	Larceny	Burglary	Robbery	Auto Theft
Lead 4	12.59	1.29	-0.07	96.84	-0.66	17.04	1.20
	(3.171)	(2.544)	(-0.490)	(4.382)	(-0.045)	(5.191)	(0.183)
Lead 3	4.80	0.13	-0.05	20.81	-13.92	11.27	-18.73
	(1.217)	(0.256)	(-0.366)	(0.948)	(-0.965)	(3.457)	(-2.870)
Lead 2	19.73	1.00	0.60	71.44	25.63	36.97	8.75
	(5.007)	(2.059)	(4.079)	(3.257)	(1.777)	(11.349)	(1.341)
Lead 1	10.71	0.82	0.60	5.66	10.63	21.51	15.89
	(2.745)	(1.711)	(4.061)	(0.261)	(0.744)	(6.666)	(2.459)
Open	1.40	0.69	0.88	6.82	3.87	4.14	9.37
	(0.355)	(1.442)	(5.926)	(0.310)	(0.267)	(1.267)	(1.430)
Lag 1	4.27	-0.35	0.89	29.63	5.57	12.08	32.95
	(1.027)	(-0.719)	(5.658)	(1.280)	(0.366)	(3.513)	(4.785)
Lag 2	-20.48	-2.56	0.57	-173.26	-70.49	-4.90	-21.59
	(-4.467)	(-4.824)	(3.316)	(-6.790)	(-4.200)	(-1.292)	(-2.844)
Lag 3	13.40	1.08	0.67	-47.63	7.40	6.03	9.86
	(2.566)	(1.765)	(3.403)	(-1.638)	(0.387)	(1.397)	(1.141)
Lag 4	14.74	1.23	0.75	-44.91	42.04	14.42	31.14
	(2.424)	(1.761)	(3.269)	(-1.326)	(1.888)	(2.867)	(3.091)
Lag 5	19.79	5.02	0.37	271.67	140.78	32.73	132.77
	(2.418)	(5.382)	(1.203)	(5.963)	(4.698)	(4.837)	(9.796)
Lag 6	63.08	6.49	0.47	472.50	71.73	34.60	233.09
	(4.981)	(4.493)	(0.981)	(6.699)	(1.546)	(3.303)	(11.109)
Lag 7	41.44	0.57	-0.99	223.20	168.21	48.44	89.83
	(3.547)	(0.430)	(-2.262)	(3.430)	(3.931)	(5.012)	(4.641)
N	57761	57029	57847	57841	57838	57842	57846
F(65,*)	299.7	100.3	70.1	116.1	288.6	112.6	272.5
Prob > F	0.0	0.0	0.0	0.0	0.0	0.0	0.0
R-squared	0.826	0.742	0.763	0.801	0.697	0.892	0.852

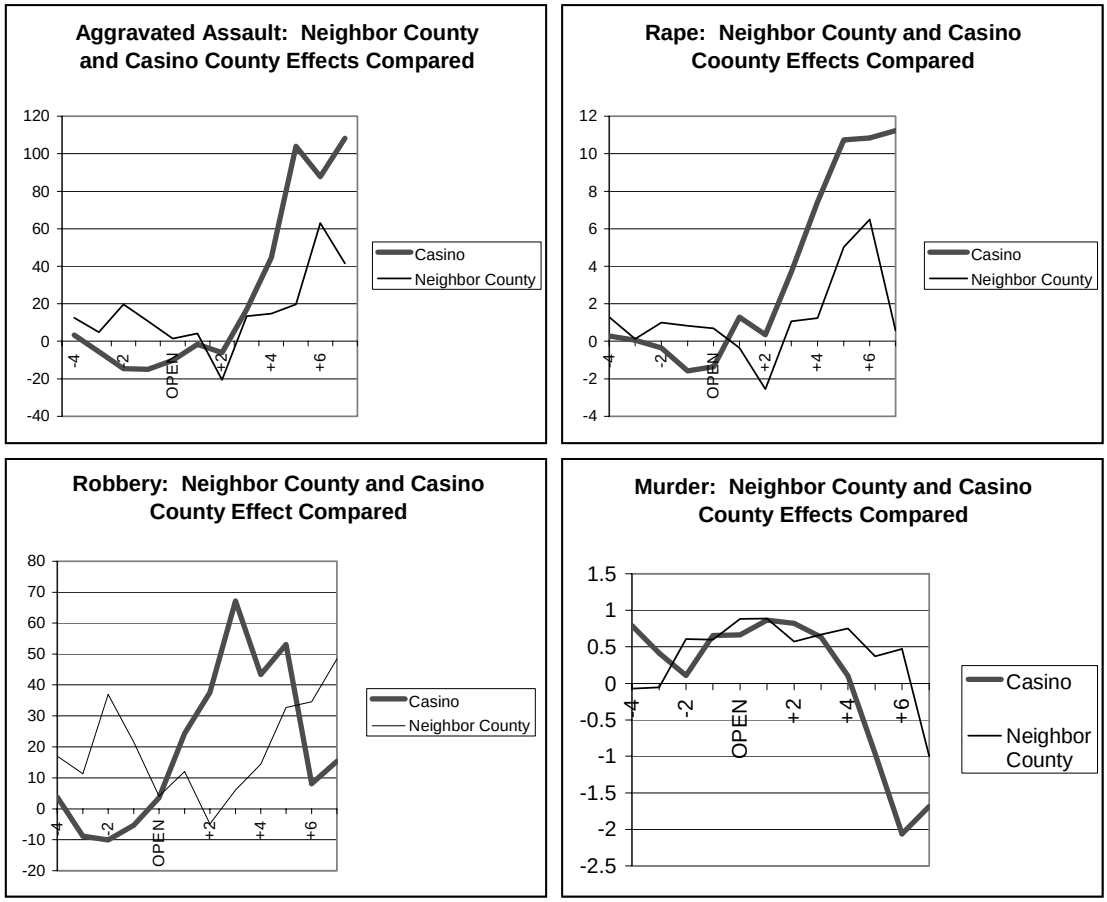
are in Nevada, draw their customers from outside their immediate area. However, our estimates do not rely on these casinos to identify the effects, because these casinos opened prior to 1977.

Table 3 shows the estimated effect of casinos on crime rates in neighboring counties. When the neighbor variables were included the host county crime coefficients were virtually unchanged, both in terms of point estimates and statistical significance. The correlation of the host county lead and lag coefficients of casino opening between the two regressions was higher than .99 for aggravated assault, rape, larceny, burglary, and auto theft, and was .985 for murder and .979 for robbery.

The pattern of crime increases in counties adjacent to casino counties showed no evidence of compensating reductions in crime and therefore no evidence of crime shifting. For years before the opening of casinos, there is virtually no impact of the casino on crime rates in neighboring counties. Generally, the overal pattern of crime rate influences is similar to the pattern in the host county, with crime increases beginning after three years of casino introduction, but attenuated relative to the host county effect. For example, Figure 9 shows the coefficients for neighboring counties for aggravated assault (thin line) compared to the host county coefficients (heavy line). The crime rate for aggravated assaults in counties neighboring casino host

counties is insignificantly different from zero for five out of the first seven years of the sample (four years before casino opening up to two years after opening), but thereafter all of the coefficients are statistically significant and positive. Comparison to the heavier line showing the host county coefficients reveals that in both the host county and neighboring counties there is little impact of the casino until approximately the third year after opening. From that point the crime rate begins to rise, with the crime rate in neighboring counties rising less than in the host county. The pattern in Figure 9 is consistent with a spillover effect for aggravated assault.

Figure 9: Neighbor County Effects: Violent Crime Rates on Vertical Axis

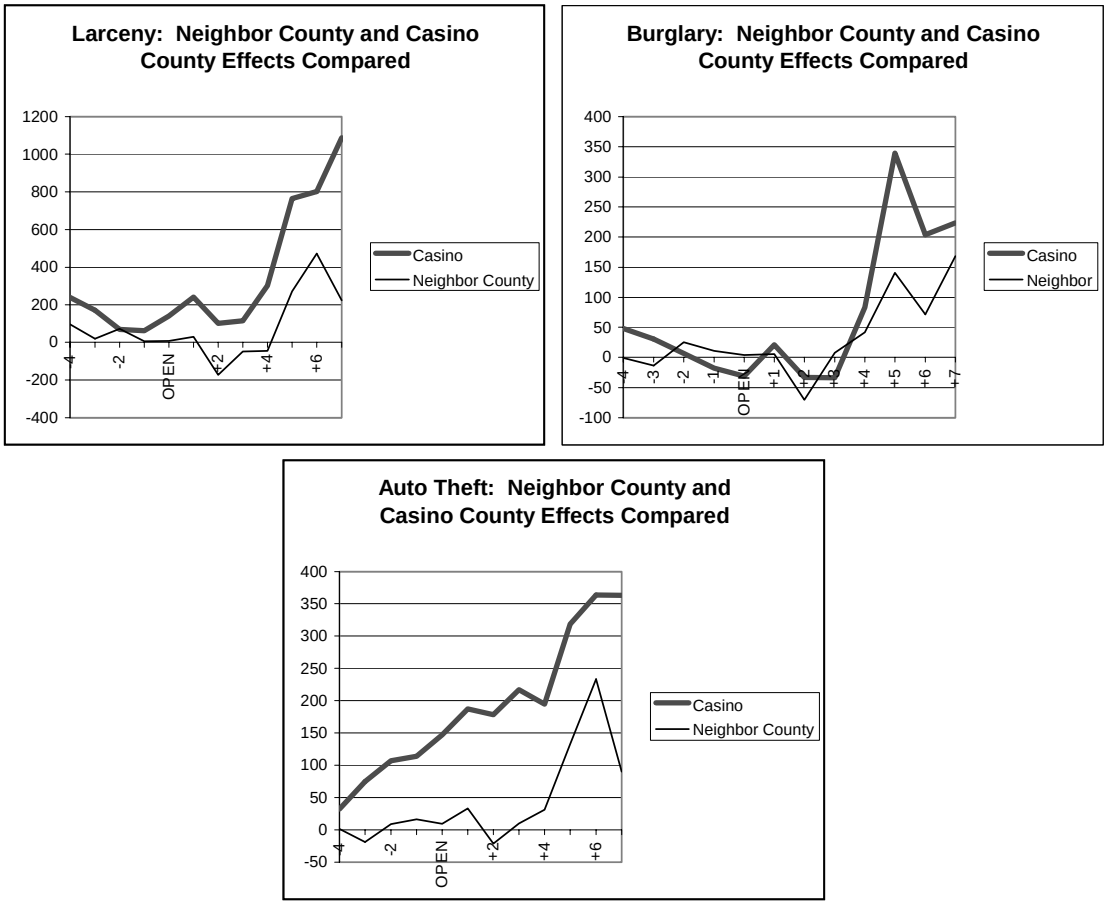


Rape exhibits a similar pattern. Robbery rates fell in neighboring counties before the opening of casinos. However, starting in the second year after opening robbery rates increased substantially. The U-shaped pattern for the neighboring county crime rate with the base two years after casino opening is a strong indicator that casinos openings lead to robbery spillover effects in neighboring counties.

Murder rates in the neighboring county are not discernably different after the introduction of a casino.

The lack of a pattern attributable to the opening of casinos agrees with the host county effects described in the previous section. Figure 10 plots the host county and neighbor county coefficients for property crime. The pattern of increased crime in neighboring counties beginning three or four years after introduction of casinos is apparent for larceny and burglary. As before, the effect in neighboring counties is smaller than in the host county.

Figure 10: Neighbor County Effects: Property Crime Rates



In our discussion of host county auto theft rates we speculated as to why the host county estimated coefficients presented a different pattern of continually growing crime. This pattern of host county coefficients did not appear to be closely related to the introduction of casinos. However, auto theft for neighbor counties displays the pattern of crime increases observed for other crimes. There is a discernably different crime rate three or more years after the opening of the neighboring casino, but not in the years before. The neighbor county effect suggests spillover of auto theft crimes due to the casino, even though host county effects are primarily driven by non-casino factors.

Taking all crimes into account, the data contain no evidence of compensating reductions in the crime rate of neighboring counties when crime rises in casino counties. The evidence more strongly supports spillover effects for all crimes but murder when casinos are introduced. The spillover effects are on the order of half the size of the casino host county effect. Therefore, we would conclude that casinos create crime, rather than attract it from elsewhere.

VI. Cost Implications

The Table 2 coefficients allow us to estimate the fraction of observed crime due to casinos. In this section we combine these estimates with information about the cost of each crime to estimate social costs.

A. Share of Observed Crime Due to Casinos

Summing the estimated number of crimes attributable to casinos (for each county accounting for how many years the casino was in operation) and dividing by the casino counties' total population for each year measures the contribution of casinos to observed crime. Very little crime was due to casinos until the 1990s. Thereafter a growing percentage of observed crime was attributable to casinos. In 1996, the last year of our sample, casinos accounted for 10.3 percent of violent crime, and 7.7 percent of property crime in casino counties. Estimates of the share of crime attributable to casinos in the same year for individual crimes ranged between 3 and 30 percent. Auto theft was the highest, followed by robbery at 20 percent. The values for the rest of the offenses were between 3-10 percent.

B. Costs of Casino-Induced Crime

Recent studies have estimated the social costs of index crimes. We use total cost per victimization figures adjusted to 1998 dollars using the CPU-U to calculate the total cost of the crimes committed in casino counties that are attributable to the casino presence according to the coefficients in Table 2.[32] We also compute the crime cost for casino counties on a per adult basis. Both results are shown in Figure 11.

Figure 11 shows that total costs were relatively low over most of the 1980s, rising significantly only after 1988. By the end of the period, total costs for the 167 casino counties reached $1.3 billion per year in 1995 and 1996.[33] On a per adult per year basis, the costs were $1.10 or below until 1984, between $5 and $9 through 1988, $33 in 1990, $65 in 1995, and $63 in 1996, the last year of our sample.

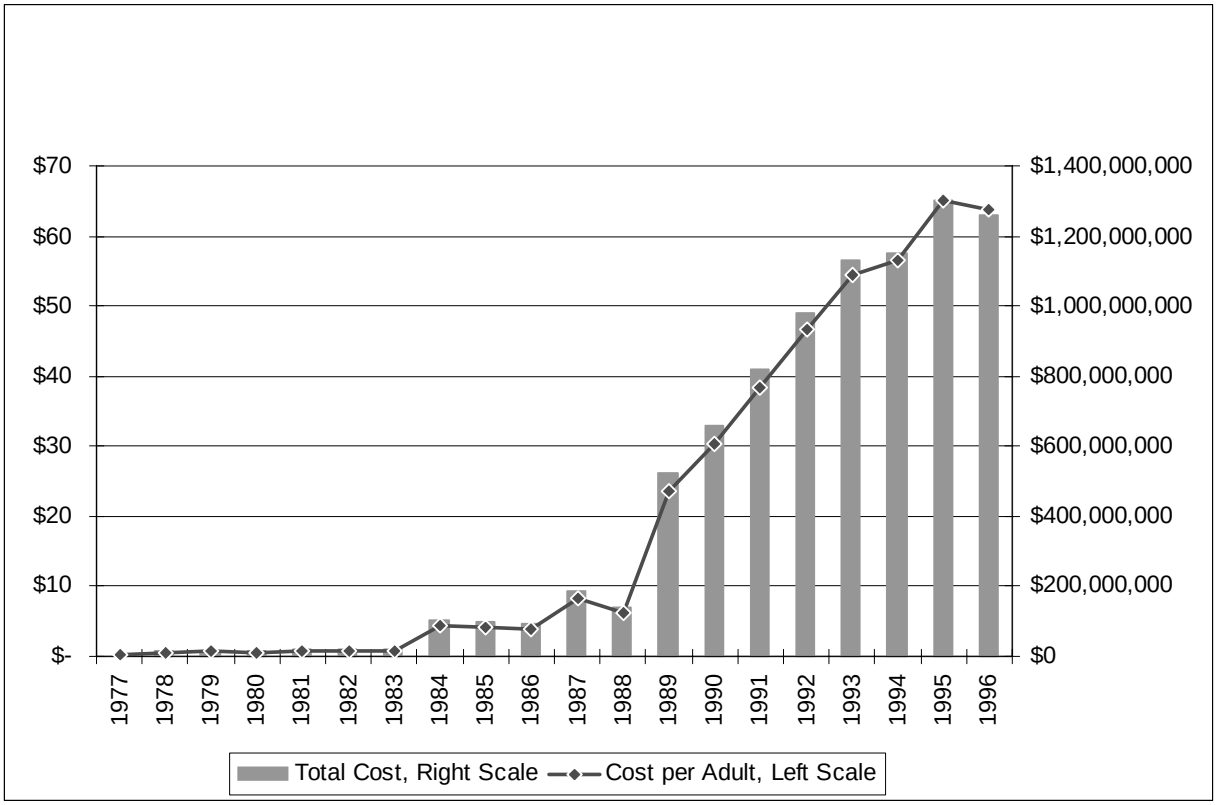
We can compare these cost estimates with others that relied on different methodology. Social costs of casinos have commonly been estimated in terms of the average cost imposed on society by a representative problem and pathological (P&P) gambler[34] multiplied by their number. In the most recent comprehensive

[32]See Miller, Cohen, and Wiersema, 1996, column 4 of Table 9, p. 24.

[33]The precise figures were $1.302 billion in 1995 and $1.275 billion in 1996.

[34]Some studies group problem and pathological gamblers, some treat them separately. Costs are computed by learning the behavior of P&Ps through direct questionnaires and surveys.

Figure 11: Casino Crime Costs: 1977-1996



study of this type of which we are aware, Thompson, Gazel, and Rickman (1996b) found that total social costs were $135 per adult in 1996 dollars, of which $57 (42 %) were due to police and judicial-related costs and thefts.[35] Thompson, *et al.* reported that they intentionally "projected numbers believed to be very conservative," and that the crime costs in their sample (Wisconsin) were probably lower than similar costs in other locations. For all of these reasons, and taking into account the different samples and methodology, their estimate is remarkably close to the direct costs estimated here for 1995-96 of $65 and $63. Applying the Thompson, *et al* proportions to our data, total social costs in those years would be $156 and $151 per adult.

[35]The social-cost impact of casino-related serious problem gamblers was $138,453,113. Dividing this by the number of adults over 20 in the counties with casinos gives the per adult figure in the text. The proportion of costs due to police, theft, and judicial-related costs is determined from their tables A-2 and A-5.

C. Pigouvian Taxes

What are the policy implications of casino-induced crime? Standard Pigouvian corrective theory for an industry with externalities is that it should be taxed by an amount equal to the costs that it imposes on society. By internalizing the externalities, corrective taxes would cause casinos to adjust their operations or go out of business. Only those that could pass a cost-benefit test by compensating society for the damage they cause would continue to operate. Relative to the revenues for a representative casino of about $230 per adult each year from nearby residents, Pigouvian corrective taxes for the seven index I crimes would represent 25-30 percent of revenues. If other social costs are ultimately identified, required taxes would be higher.

An alternative to Pigouvian taxes depends on whether gambling can be offered in a manner that does not lead to externalities. For example, can gambling be provided in a manner that does not generate problem and pathological gamblers, and thereby lead to fewer crimes? If so, it may be less costly to society to implement than the response based on Pigouvian taxes.

VII. Conclusions

Our analysis of the relationship between casinos and crime is the most exhaustive ever undertaken in terms of the number of regions examined, the years covered and the control variables used. Using data from every U.S. county from 1977 to 1996 and controlling for over 50 variables to examine the impact of casinos on the seven FBI Index I crimes (murder, rape, robbery, aggravated assault, burglary, larceny and auto theft), we concluded that casinos increased all crimes except murder, the crime with the least obvious connection to casinos. Most offenses showed that the impact of casinos on crime increased over time and began about three years after casino introduction. This pattern is consistent with the theories that problem and pathological gamblers commit crime as they deplete their resources, that nonresidents who visit casinos may both commit and be victims of crime, and that casinos lower information costs of crime and increase the potential benefits of illegal activity. These effects outweigh the potentially positive effects on crime that casinos may have through offering improved labor market opportunities.

According to our estimates, between 3 and 30 percent of the different crimes in casino counties can be attributed to casinos. This translates into a social crime cost associated with casinos of $65 per adult in 1995 and $63 per adult in 1996. These figures do not include other social costs related to casinos such as crime in neighboring counties, direct regulatory costs, costs related to employment and lost productivity, social service and welfare costs. Overall, 8 percent of property crime and 10 percent of violent crime in counties with casinos was due to the presence of the casino. Although robbery, the offense that exhibited the largest increase, is classified as a violent crime, it is more appropriately classified as a property crime in that its motivation is financial.

We also investigated whether the crime in casino counties is attracted (moved) from other regions or is created. Counties that neighbor casino counties generally experienced crime increases whose pattern matched the pattern in casino counties, but smaller. This indicates that crime spilled over from casino counties into

neighbor counties, rather than shifting crime from one area to another.

In future research we hope to refine this study. Questions include whether different types of casinos have different impacts on crime. For example, do riverboat casinos affect crime in the same manner as land-based casinos or casinos based on Indian Reservations? Is there a difference based on geographic areas? Do casinos in rural areas affect crime in the same way as those in more highly populated areas? We will also try to decompose the total effect into the fraction due to local residents and visitors. We will also extend the data set as new data become available.

APPENDIX I

Definitions of FBI Part I Index Crimes[36]

The FBI Uniform Crime Report Part I offenses as follows:

I. Violent Crime–includes murder, rape, robbery and aggravated assault.

A. Murder and Non-negligent Homicide is the willful (non-negligent) killing of one human being by another and is based on police investigations, rather than the evaluations of a medical examiner or judicial body. Deaths caused by negligence, attempts to kill, assaults to kill, suicides, accidental deaths, and justifiable homicides are excluded from this category. Justifiable homicides are limited to the killing of a felon by a law enforcement officer in the line of duty and the killing of a felon by a private citizen.

B. Forcible Rape is the carnal knowledge of a female forcibly and against her will. Included are rapes by force and attempts or assaults to rape. Statutory offenses (where no force was used and the victim is under age of consent) are excluded.

C. Robbery is the stealing, taking or attempting to take anything of value from the care, custody or control of a person or persons by force, threat of force or violence and/or by putting the victim in fear. Robbery includes attempted robbery. Robbery is divided into seven subclassifications: street and highway (which accounted for 52 percent of all robberies in 1992), commercial house (11.9 percent), residence (10.1 percent), convenience store (5.3 percent), gas or service station (2.5 percent), bank (1.7 percent) and miscellaneous (13.1 percent).

D. Aggravated Assault is the unlawful attack by one person upon another for the purpose of inflicting severe or aggravated bodily injury. It includes assault with intent to kill. This type of assault is usually accompanied by the use of a weapon or by means likely to produce death or great bodily harm. Simple assaults are excluded.

[36]The definitions are taken from *Crime in the United States: 1993* (U.S. Department of Justice, Federal Bureau of Investigation), Appendix H, 380-381. The statistics quoted for 1992 are taken from *Crime in the United States: 1992, Section One.*

II. Property Crime–includes burglary, larceny and auto theft.

A. Burglary is the unlawful entry of a structure to commit a felony or a theft. It includes attempted forcible entry, attempted burglary and burglary followed by larceny.

B. Larceny (except motor vehicle theft) is the unlawful taking, carrying, leading or riding away of property or articles of value from the possession or constructive possession of another. Larceny is not committed by force, violence or fraud. Attempted larcenies are included. Embezzlement, "con" games, forgery, worthless checks, etc., are excluded. Larceny is subdivided into a number of smaller classifications: items taken from motor vehicles (22.6 percent of all larcenies in 1992), shoplifting (15.8 percent), taking of motor vehicle accessories (14.0 percent), taking from buildings (14.0 percent), bicycle theft (5.9 percent), pocket picking (1.0 percent), purse snatching (0.9 percent), taking from coin operated vending machines (0.9 percent), and all others (24.8 percent).

C. Motor vehicle theft is the theft or attempted theft of a motor vehicle. A motor vehicle is self-propelled and runs on the surface and not on rails. Motor vehicle theft includes all cases where vehicles are driven away and abandoned, but excludes vehicles taken for temporary use and returned by the taker. Specifically excluded from this category are motorboats, construction equipment, airplanes and farming equipment.

APPENDIX II

Explanation of County level Data

The number of arrests and offenses for each crime in every U.S. county from 1977-1996 was obtained from the Federal Bureau of Investigation's Uniform Crime Report County-level Data. When the UCR data had an observation with a FIPS code that did not match any county listed in the codebooks, that observation was deleted.

One significant problem with the offense data has occurred since 1985. When ICPSR compiles the FBI data, it cannot distinguish between legitimate values of 0 and values of 0 that should have been coded missing.[37] If an individual offense or arrest category had a value of 0 and that county had non-zero values for other crime categories, we used the raw data. This rule was followed because the FBI and ICPSR indicated that law enforcement agencies normally report the data for all crimes and do not selectively send data for some types of crimes and not for others. If the number of offenses and arrests was 0 for all categories in a given county in a given year, then that county was assigned missing values for all offense and arrest rates.

State populations were taken from the Statistical Abstract of the United States. The county population, age, sex and race data for all years except 1990 and 1992 were obtained from the U.S. Department of Commerce, a division of the Bureau of the Census. All population measures estimate the July 1 population for the respective years.[38] The age distributions of large military installations, colleges, and institutions

[37]Ken Candell of the FBI and Chris Dunn of ICPSR have provided much assistance with these problems.

[38]For further descriptions of the procedures for calculating intercensus estimates of population, see ICPSR (8384): "Intercensal Estimates of the Population of Counties by Age, Sex and Race (United States): 1970-1980." U.S.

were estimated by a separate procedure. The counties for which special adjustments were made are listed in the report.[39] The 1990 and 1992 estimates were not available from the Census Bureau. The 1990 data were estimated by taking an average of the 1989 and 1991 data. The 1992 data were estimated by multiplying the 1991 populations by each county's 1990-1991 growth rate. The Bureau of the Census provided the data on land area in square miles.[40]

Data on income, unemployment, income maintenance and retirement were obtained from the Regional Economic Information System, a component of the Bureau of Commerce. Income maintenance includes Supplemental Security Insurance (SSI), Aid to Families with Dependent Children (AFDC), food stamps, and other income maintenance (which includes general assistance, emergency assistance, refugee assistance, foster home care payments, earned income tax credits, and energy assistance). Unemployment insurance benefits include state unemployment insurance compensation, Unemployment Compensation for Federal Civilian Employees (UCFE), Unemployment for Railroad Employees, and Unemployment for Veterans (UCX), and other unemployment compensation (which consists of trade readjustment allowance payments, Redwood Park benefit payments, public service employment benefit payments, and transitional benefit payments). Retirement payments included old age survivor and disability payments, railroad retirement and disability payments, federal civilian employee retirement payments, military retirement payments, state and local government employee retirement payments, federal and state workers' compensation payments, and other forms of government disability insurance and retirement pay.

Department of Commerce, Bureau of the Census. Winter 1985. ICPSR, Ann Arbor, MI 48106. Also, see "Intercensal Estimates of the Population of Counties by Age, Sex and Race: 1970-1980 Tape Technical Documentation." U.S. Bureau of the Census, Current Population Reports, Series P-23, No. 103, "Methodology for Experimental Estimates of the Population of Counties by Age and Sex: July 1, 1975." U.S. Bureau of the Census, Census of Population, 1980: "County Population by Age, Sex, Race and Spanish Origin" (Preliminary OMB-Consistent Modified Race).

[39]U.S. Bureau of the Census, Current Population Reports, Series P-23, No. 103, "Methodology for Experimental Estimates of the Population of Counties by Age and Sex: July 1, 1975." U.S. Bureau of the Census, Census of Population, 1980: "County Population by Age, Sex, Race and Spanish Origin" (Preliminary OMB-Consistent Modified Race), pp. 19-23.

[40]Land area includes intermittent water and glaciers that appear on census maps and in the TIGER file as hydrographic features. It excludes all inland, coastal, Great Lakes and territorial water. Inland water consists of any lake, reservoir, pond or similar body of water that is recorded in the Census Bureau's geographic data base. It also includes any river, creek, canal, stream or similar feature that is recorded in the data base as a two-dimensional feature (rather than a straight line). Rivers and bays that empty into these bodies of water are treated as inland water from the point beyond which they are narrower than one nautical mile across. Coastal and territorial waters include portions of the oceans and related large embayments, such as the Chesapeake Bay and Puget Sound, the Gulf of Mexico and the Caribbean Sea, that belong to the United States and its possessions.

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