"Video Games and Crime"

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ABSTRACT: Psychological studies find that video game play is associated with markers for violent and antisocial attitudes. It is plausible that these markers indicate either whetted or sated preferences for antisocial behavior. I investigate whether a proxy for video gaming is associated with the prevalence of various crimes and find evidence that gaming is associated with significant declines in crime and death rates. These results are robust to various alternative specifications. Other youth related leisure activities - sports and movie viewing – generate smaller or no effects. These results cast doubt on the desirability of proposed restrictions on video game marketing.

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1. Introduction

Regulating the content and marketing of video games so as to curb crime and violence has received growing interest among policymakers. Substantial evidence from psychological studies indicates a potential link between violent video game play and tendencies toward violent and possibly criminal activities. If so, these represent the sort of negative externality often addressed by public policy. To date, proposals to regulate of the content of games have not been adopted due to both the difficulty in defining and implementing rules regarding the content appropriateness and the possible infringement of free speech protections.

In the US, the Federal Trade Commission has made six reports to the US Congress on the broader topic of violence in media between 2000 and 2007 (FTC, 2007). As of June, 2006, there were seven bills in Congress addressing violence in video games (CNET News, 2006). So far, the US regulatory intervention has focused on placing limits on marketing to minors. Legislation aimed at video game violence is also proposed in many US states. Many broader state level restrictions have been struck down by the courts because they were found to infringe on constitutional rights (Theirer, 2006). More interventionist policies are under consideration in the EU (MacWorld, 2007), Britain (Reuters, 2007), and China (Peoples Daily Online, 2007).

The concern presupposes that violence in the video game context induces gamers into violent behaviors beyond of the gaming context. While the evidence indicates that these games heighten physical and emotional reactions related to violent, criminal, and antisocial attitudes, so far as I know, there have been no studies linking video game usage to observed behaviors in gamers. Besides the psychological theories, economic theory also suggests that it is plausible

that one develops a proclivity for actual violence through virtual violent behavior. This might result from the accumulation of a specific stock of human capital that increases the consumption level required to generate a given level of utility as with rational addiction models (Becker and Murphy, 1988). Gamers without immediate access to a game console required to"consume" virtual violence may instead choose to engage in violent behaviors outside of the virtual environment.

Alternatively, it is also plausible that virtual violence tends to diminish one's marginal utility from further violent activities. If virtual and actual violence are substitutes, increased consumption of violence through virtual gaming would reduce the demand for actual violence. If so, immediately after engaging in violent video game play, we might expect a gamer to display the enhanced emotional and physical responses normally associated with these activities. However, this experience would serve to partially sate the gamer's demand for violence, whether it is virtual or actual. That is, the psychological evidence is consistent with either virtual violence leading to an increase or a decrease in actual violence. More to the point, it is impossible to tell *a priori* if violent video game play and violent or antisocial behaviors appear as are complements or substitutes. While evidence of a complementary effect would lend support to a more interventionist policy, evidence of a substitution effect could undermine such support.

Relatedly, it is possible that violent games are particularly attractive to otherwise violent individuals. Independent of whether violent video game play causes a behavioral change in which individuals become more violent, it could substitute for time spent in violent activities thereby decreasing the total amount of violence. Dahl and DellaVigna (2009) find evidence that the voluntary incapacitation around the time of the showing of violent movies is associated with

short-run reductions in crime rates. Kendall's (2007) findings suggest that rapes decline with the availability of online pornography, especially among offenders for whom the internet-induced a relatively larger decline in the non-pecuniary price of pornography – male teenagers. In both cases, it is possible that individuals with a greater risk of an illicit behavior self-select into the related virtual behavior instead. Ward (2010) finds that much of the video-game-to-violence correlation is due to more violent individuals self-selecting into video game play. Violent media exposure may not only directly affect violent outcomes, but may also affect them indirectly as it alters time spent in substitute activities that may be even more violent.

I implement tests to measure a possible game play to violence linkage that indicate an overall reduction in crime and mortality. I proxy variation in video game play with changes in the number of game stores in an area. I employ a count data panel estimator that allows for fixed county and year effects that relate the number of crimes by category and mortalities of different types to the number of game stores. Because stores are a proxy for overall game play, and not just violent game play, I cannot test the specific role of violence in games on crime, only the role of more video game play overall. Still, because the overall effect is an average of effects from violent game play and non-violent game play, estimates of an overall effect place restrictions on the magnitudes of the constituent parts. For six of eight categories of crimes, I find significant reductions in crime rates associated with more game stores. In addition, mortality rates fall with games stores. In contrast, proxies for other teen and young adult leisure activities, sporting goods stores and movie theaters, exhibit either no similar effect or a smaller effect. Finally, robustness checks suggest that these findings are not likely the result of reverse causality.

2. Background

Early computer games in the 1960s were text-based strategy games developed by hobbyists usually associated with computer science programs at major universities. The video game industry, as such, was initially arcade based. The first video game consoles designed for home play emerged in the mid-1970s, causing arcade-based play to begin to wane. Ever increasing capabilities of gaming consoles, largely due to advances in computer technology, enabled ever more sophisticated and realistic games. Improvements in features, processor speeds, and other capabilities are often categorized into gaming generations - the seventh generation emerged in 2004 - and have led to ever increasing demand for gaming. As the technology has advanced, depictions of social interactions, including violent interactions, have become increasingly more realistic. Table 1 indicates that both unit and dollar sales volumes increased nearly five-fold between 1996 and 2007 with nearly $9.5 billion in annual sales in the US currently.

Public policy toward gaming is complicated by a desire to protect minors, while avoiding impinging on choices for adults. According to the Entertainment Software Association (ESA), video gaming is disproportionately a youth activity with 30-40% of all gamers aged 18 years or younger.[1] Nevertheless, many gamers who were introduced to gaming decades ago have remained avid gamers into their adult years so that the average age of gamers is 33. In the US, the primary content policy has been mandatory use of Entertainment Software Rating Board (ESRB) ratings of games, analogous to the Motion Picture Association of America (MPAA) ratings of movies. Based on their content, games are rated as for Early Childhood (EC), Everyone (E), Everyone aged more than 10 (E10+), Teen (T). Mature (M) and Adult Only

(AO).[2] These designations are meant to allow parents access to information to better ensure that individual

games are appropriate for their children while simultaneously allowing adults to choose games with content not usually deemed appropriate for children. The ESA reports that 85% of all game titles are rated EC, E, E10+ or T. While this system appears to satisfy many concerns of video game critics (Federal Trade Commission, 2007), it is not foolproof and some children are able to play violent video games with or without parental consent.

Many psychological studies provide support for this presupposition. These studies of video game violence are usually conducted within the context of more general studies of violence in media influencing behaviors, especially behaviors among the youth. Dozens of studies have investigated the influence of violence in movies and television, while fewer have examined music and, especially, video games. Reviews and meta-analyses by Bensley and Van Eenwyk (2001), Anderson and Bushman (2001), Sherry (2001) and Anderson (2004) analyzed sets of 29, 35, 30, and 44 non-mutually exclusive articles on the psychological effects of video game violence respectively.

These studies can generally be categorized as either experimental or correlation studies. In experimental studies, typically a small pool of subjects is randomly assigned to play a violent game while the control subjects play a less violent game. Typically, they find statistically significantly heightened cardiovascular activity and hostility measures associated with playing more violent games. In correlation studies, subjects are surveyed regarding their typical video game play and aggressive attitudes or behaviors. These studies typically find a positive statistically significant correlation between the two, but rarely control for other covariates

(Ward, 2010). In both types of study, there is no scope for identifying the activity that video game play substitutes for or for linking the video game exposure to actual violent behaviors. The methodology proposed below has the advantage of examining the effects of gaming on actual behaviors but cannot identify whether the effects emanate from a direct effect on behavior or from a substitution from an even more violent behavior.

3. Empirical Model

The estimation strategy I propose relates variation in a proxy for video game play with measures of criminal and violent behavior. Panel data for over 400 counties and eleven years allow idiosyncratic location effects to be absorbed into dummy variables for each county and idiosyncratic changes over time to be absorbed into dummy variables for each year. Controlling for fixed county and year effects and other time-varying factors affecting the supply and demand for crime and violence, the video game play proxy is related to various measures of criminal behavior and violence. The key challenges of interpretation of the results emanate from the appropriateness of the video game usage proxy and the specification of the data generating process.

The relationship between crimes committed or mortalities is modeled with a reduced-form behavioral relationship. It is informative to examine if the video game effect differs substantially from other youth activities. Increased time spent in any activity could directly affect criminal behaviors or could substitute for time in criminal activities. I compare variation in video game stores, a proxy for video game play, with changes in the number of game stores in an area. Rather than observations on individuals' behaviors, the available data represent aggregations of

individuals to the county and year level. I model the number of outcome events of type *j* in a county *k* and year *t* as following a Poisson distribution. My main estimating equation will be of the form:

$$E\left(Outcome\ Events_{kt}^{j}\right) = \exp\left(\delta_k + \delta_t + \beta X_{kt} + \gamma_1 \ln\left(Video\ Game\ Play_{kt}\right) + \gamma_2 \ln\left(Sports\ Play_{kt}\right) + \gamma_3 \ln\left(Movie\ Viewing_{kt}\right)\right)$$

The parameter values for the leisure activities can be interpreted as the elasticity of the mean outcome with respect to the activity. This specification implicitly assumes a constant elasticity functional form.[3] The control variables, X_{it}, include time-varying measures of income, unemployment, population, youth population, and the number of police officers. Levitt (2004) also points to findings of associations between the prison population, the crack epidemic and abortion legalization on crime rates. These are not addressed here mainly due to data limitations as time-varying county-level values are not readily available. Moreover, because these measures are not likely correlated with video game play, the possible omitted variable bias is likely small.

There is a concern that the standard Poisson estimator will yield estimates of standard errors that are biased downward leading one to incorrectly reject of the null hypothesis of parameter values equal to zero. A possible source of this bias can emerge from the actual distribution differing from the Poisson due to over-dispersion. One common solution is to estimate under the assumption of a negative binomial distribution that allows for over-dispersion. This solution is problematic in this case because it is not clear that a single over-dispersion parameter describes distributional differences across counties. Likewise, attempting to estimate separate over-dispersion parameters for each county is hampered by few observations per county. Instead, I report bootstrapped standard errors from 200 repetitions of case resampled

observations. Bootstrapped standard errors will yield consistent standard errors under more general distributional assumptions (Cameron and Trivedi, 1998, pp 164-8).

4. Data Description

An available and consistently measured proxy measure for the amount of video game play for a large number of observations is the number of video game stores operating in a county in a year. While consistently measured, the number of game stores is an imperfect measure of video game play. First, stores may be proportional to sales, a flow, while the incidence of violent events is related to concurrent gaming, possibly related to the stock of games owned by consumers. If the flow to stock ratio varies, this proxy loses its informative value. Because video gaming technology continues to improve, newer games are usually preferred to the older games already in a gamer's inventory.[4] Prieger and Hu (2006) find that game console demand is positively affected by the number of new game titles but not by the number of game titles over three months old. This provides some evidence that the flow, rather than the stock, of video games may not be a bad proxy for the amount of gaming.

Second, areas with similar overall demand can be served with fewer large stores or more small stores. Among the main determinants in the size distribution of stores will be customer density and returns to store scale. Fewer larger stores with deeper inventories may experience fewer stock outs of a specific title implying possible returns to scale. Conversely, more smaller stores imply decreased transportation costs on the part of store customers leading to increased demand. To the extent that these sorts of geographic market specific characteristics are time

invariant, they could be accounted for using county fixed effects and should therefore yield unbiased estimates.

Third, the number of stores does not distinguish between demand for violent video games and demand for relatively nonviolent video games. It is possible, that an increase in video gaming is related to a larger increase in nonviolent game playing with a more pacific effect, than on violent game playing with a more inflammatory effect. The net effect could be calming and, thus, crime reducing. While such a relationship between an increase in demand for games and a decrease in the relative demand for violent content of the portfolio of games purchased is possible, it is unlikely. If the number of games stores serving an area increases, all else equal, it is likely that both violent and nonviolent game play increases. Still, it useful to note that the analysis below only relates crime and violence to a proxy for overall game play generally and not to a proxy for violent game play specifically.

Fourth, the analysis below takes variations in the number of game stores as given and does not identify the sources of changes in gaming intensity. It is possible that an unobserved omitted variable is simultaneously affecting both consumers' demand for game play and potential criminals' propensities to commit a violent act. If so, the analysis will not identify a structural relationship between gaming and violence, but instead it would merely indicate that a change gaming intensity is a coincident "marker" for changes in violent behavior. In particular, the methodology could suffer from possible reverse causality. That is, game stores could close more often due to increased criminal activity. The usual empirical strategy employed is to employ an instrumental variable estimator that first identifies variation in game play from causes independent of violence and then relates this variation to violent behaviors. Unfortunately, I

have been unable to uncover a valid instrumental variable; one that is related to gaming supply or demand but does not directly affect violent behavior. Below, I report some robustness checks that suggest that not all of the observed effects are due to reverse causality.

The possibility of omitted variable bias is mitigated by three separate aspects of the specification. First, besides county and year fixed effects, the specification includes time-varying measures for the common proximate causes of crime and violence such as the size of the "youth" population, poverty, unemployment, and police presence. Because these account for much of the systematic variation in crime rates, they tend to reduce the likelihood of the existence of an important omitted variable capable of causing significant bias.[5] Second, the nature of gaming and criminal populations put restrictions on omitted variables. Video game play is widespread throughout the population while commission of a violent or criminal act sufficiently egregious to be recorded as a statistic is an extreme event affecting a considerably small fraction of gamers. A candidate omitted variable would have to shift the mean of the distribution of gaming intensity while simultaneously increasing the probability measure in the tail of the distribution of violent acts. Third, likely candidate omitted variables tend to bias results toward finding a complementary effect rather than substitution effect. For example, a policy intervention that attracts would-be criminals, such as an active youth center or nighttime basketball, would likely simultaneously reduce both video game play and violence. Likewise, unmeasured changes police effectiveness that makes an area safer would likely reduce crime and allow for more activities outside of the home. These effects suggest that omitted variable bias very well could result in the reported magnitudes under-measuring the actual effects.

The hypotheses described above are tested using a panel of data from multiple sources comprising the counties of the US for the years 1994-2004. The amount of video gaming is measured indirectly from the number of video game stores in the county as measured by the US Census Bureau's County Business Patterns data.[6] The US Census Bureau also makes annual population estimates available for each county by age category.[7] The US Bureau of Labor Statistics (BLS) reports state level unemployment rates monthly, from which I use the midyear rate for a state for each county within the state[8]. Contained within the Federal Bureau of Investigation's (FBI's) Uniform Crime Reports (UCR), is the Law Enforcement Officers Killed and Assaulted (LEOKA) data. These data include the number of police officers for each agency for each year[9]. The total number of officers is aggregated to the county in which the agency operates and, to decrease the possible effects of endogeneity, values lagged one year are used. Crime data come from the FBI's UCR also contain year and county level aggregate numbers of crimes committed by major categories. Finally, a measure of violent outcomes is available in the form of mortality statistics from the Centers for Disease Control and Prevention (CDC).[10] I obtained total mortality data, deaths of those aged 10-24, and deaths due to injury or poisoning for by county from 1994 to 2004.[11] Actual values are suppressed by the CDC when they are small enough to cause privacy concerns. This causes the sample size to be smaller for the measure corresponding to those aged 10-24.

County Business Patterns (CBP) data are annual data for each county in the US and include establishment, employment and payroll information for various industry classifications. For industry categories and locations with few establishments, such as specialty retail stores in less populated counties, the Census Bureau suppresses payroll and, especially, employment

information for privacy reasons. The analysis below uses the number of establishments so as to maximize the number of valid observations.

Until 1997, industries were classified based on the Standard Industrial Classification (SIC) System and from 1998 based on the North American Industry Classification System (NAICS). While many industry definitions often differ between the two, the video game stores definition did not change. The NAICS code 451120 is described as "Hobby, Toy and Game Stores" which completely bridges to the SIC code 5945 with the same description. Similarly, NAICS code 451110 and SIC code 5941 are both described as "Sporting Goods Stores" and NACIS code 512131 and SIC code 7832 are both described as "Motion Picture Theaters (Except Drive-Ins)."

While the description of sporting goods stores and movie theaters seem to describe those activities, the description "Hobby, Toy and Game Stores" is broader than the measure of video game stores desired for the analysis. To better understand the composition of the CBP data I obtain data from InfoUSA on Yellow Pages listings for the ends of years 1997, 2001, and 2006 for counts of establishments by county under subject headings that include "Video Games." Most of these were retailers, but a few were manufacturers and repairers. The average number of "video game" establishments across the nearly 3,000 matching counties was 3.42. The comparable average number of establishments from InfoUSA for the same counties was a little more than half at 1.76 and was growing over time. While the CBP measure appears to include stores other than video game stores, video game stores represent over half of all CBP stores and nearly three-quarters by 2004. Further, the correlation between the two measures was about 0.9 and the per capita measures were positively significantly correlated. Nonetheless, the inclusion

of non-video game stores in this hobby, toy and game store variable indicates that it is, at best, an imperfect measure of video game stores. While it is possible that any estimated association between this variable and crime rates emanates from the video store component, I cannot rule out variation in the number of hobby and toy stores component as the source.

Another concern is that this proxy variable omits video games sold outside of game stores. Video games have also been available from discount stores, (e.g., Walmart and Target), from computer stores (e.g., BestBuy and Circuit City), and from movie rental stores (e.g., Blockbuster). Unfortunately, there is no systematic data on video game sales from these stores nor is there much information on the relative sizes of these retail channels. One type of evidence suggests that these other sources may represent a small fraction. For example, the largest movie rental company, Blockbuster, started renting video games only in 2004, the last sample year. Even then, Blockbuster's total revenue the recent quarter was $1.0 billion, most of which was from movie rentals. In contrast, the largest video game store chain, GameStop, had revenues of $1.8 billion in the most recent quarter, almost all of which was video game related. The omission of this information will bias my results if game store sales are negatively correlated with non-game store sales rather than indicative of all sales of video games.

The FBI's primary objective with the Uniform Crime Report data is to "generate to a reliable set of crime statistics for use in law enforcement administration, operation, and management." However, partly because these data are increasingly being used by researchers studying crime, the FBI disseminates a handbook to local agencies for the uniform coding of offenses. The data report the number of crimes reported to a law enforcement agency in a county and year by type of crime. The categories of crimes available are those having to do with murder,

rape, robbery, aggravated assault, burglary, larceny, motor vehicle theft, and arson.

A number of more rural counties were too small to support video game stores, sporting goods stores, or movie theaters. Any some cases, CBP reports zero establishments but in many other cases, the number of establishments is simply missing. To ensure that the estimation results were not a result of these smaller counties with problematic data, I constrained the sample to counties with a population of more than 50,000 and with non-missing establishment data for all years. Doing so limits the sample from over 3,100 counties to more than 400 counties. These remaining counties represent over 80% of the US population. Summary statistics for this sample are reported in table 2.

5. Results

The basic regression results shows that most crimes decrease in a county as the number of game stores increases. Similar measures for sporting good stores and movie theaters yield smaller estimated effects that are more often not significantly different from zero. This pattern is also observed with mortality outcomes. These results withstand various robustness checks. First, the magnitude tends to increase over time as video gaming has become more popular. Second, the effects are stronger when video game stores are interacted with the prevalence of youths in the county. Third, most of the results are still apparent when county-specific trends are included. Fourth, the results still emerge with lag values of video game stores.

A. Basic Results

The basic crime and mortality regression results are reported in table 3. The number of

observations differs slightly across regressions because counties with no variation in a particular crime statistic are excluded from the sample that generates estimates for that dependent variable. The reported parameter estimates are computed from 200 iterations of bootstrapping.[12] Coefficient estimates are virtually unchanged by bootstrapping, however the estimated standard errors are noticeably larger. Wald tests reject the null hypotheses of all coefficients equal to zero at very high levels of confidence.

There are many common features of the estimated coefficients across regressions with different dependent variables. First, unreported fixed county effects are always jointly significant. This suggests the existence of time-invariant cross-sectional determinants of crime rates. Second, for all categories of crimes, unreported fixed year effects indicate a secular decline in crime rates. The declines in crime rates these estimates imply are large but largely mirror national average

trends over this time period.[13] Third, crime increases considerably with population but not always at a one-to-one ratio. Fourth, an increase in the percent of the population that is aged 15-24 years is usually associated with increases in crime rates. This coefficient is never negative and is significant for rape, robbery, aggravated assault, and motor vehicle theft. Fifth, better economic conditions are associated with less crime. For most measures, an increase in average earnings is associated with less crime more often than more crime but the effect is not strong. Similarly, higher unemployment rates are usually positively and significantly associated with more crime. Finally, the association between lagged police officers and crime is usually negative but only approaches significance for robberies. As Levitt (1997, 2002) and McCrary (2002) find,

this result could reflect the endogeneity of increased supply of police due to increased crime rates and the decreased crime due to a greater probability of apprehension.

The variables of particular interest are those relating to proxies for video game usage, movie theater attendance, and sporting activities. The sign of the coefficient for the natural logarithm of the number of movie theaters does not follow a consistent pattern and its magnitude never reaches the usual standards for statistical significance. The sign of the coefficient for the natural logarithm of the number of sporting goods stores is consistently negative and is statistically significant for robbery and larceny. These estimates support the claim that increased sporting activities such that the number of sporting goods stores increase by 1% lead to a general decline in crime rates by an average of about 0.05%. It is possible that some or all of this is due to an incapacitation effect in which time spent playing sports is time that a potential perpetrator is not committing a crime.

As for the proxy for video game usage, the coefficients for the natural logarithm of the number of game stores are almost always negative and are statistically significantly different from zero in all but two cases, those for murder and rape.[14] The magnitudes of the significant effects range from -0.23 for arson to -0.04 for larceny. The largest reductions are for arson, motor vehicle theft and robbery, crimes associated with the teens and young adults who also tend to be the age group associated with heavier video game usage. The average magnitude across all eight crime categories is -0.10, about twice the similar average for sporting goods.[15] These findings are consistent with increased gaming that causes a 1% increase in game stores leading to an average 0.10% reduction in crime rates.

The last three columns apply the same specification to measures of mortality rates. These results demonstrate largely the same pattern as those from the crime statistics. The sporting goods and movie theater variables are never statistically significant. The game store effect is always negative but loses statistical significant for all mortalities among those aged 10-25, possibly because the much smaller number of deaths in this group reduces the power of this test. As expected, the estimate of the game store effect on deaths due to injuries is larger, though the difference in magnitudes is not significant.[16]

B. Robustness Checks

As a first robustness check, I examine the game store effect in relation to the number of youths. Youths, here defined as those aged 15-25, were found to be associated with increases in all outcome measures and significantly more for rapes, robberies, aggravated assaults, and motor vehicle thefts as well as all mortality measures. Video game players are also disproportionally drawn from this population. An increase in gaming is more likely to draw these youths away from criminal or violent activity. If so, we would expect an even larger reduction in these outcomes where game stores increased in areas with larger youth populations. Since other coefficients are little affected by this change in specification, Table 4 reports only the coefficients for game stores, youths and their interaction from Poisson regressions of all outcomes. Each row represents estimates from different regressions with the column representing the different interactions. The interaction term is negative for all outcomes but rape and is significant for six outcomes.

Next, I attempt to deal with possible reverse causality. It is possible that game stores are closing, or opening less often, because crime rates are rising. Moreover, because games can be more easily stolen than movies or sporting goods, we might expect a larger game effect. This reverse causality may be the result of longer term trends in crime rates rather than year-to-year changes. If so, it is possible that the addition of a county-specific trend term will capture much of this effect while the year-to-year variation is due to changes in inhabitants' video game playing. Because the inclusion of over 400 trend variables in intractable, I instead linearize the specification and calculate deviations from trends for all variables. Specifically, I regresses the deviation in the logarithm of each outcome per capita against deviations in each explanatory variable. Table 5 reports the coefficients for game stores are still consistently negative and remains statistically significant for arson and motor vehicle theft. Now, however, movies are associated with murders and mortalities. Sports is now associated with fewer robberies and assaults but more mortalities. At a minimum, these findings are not consistent with video games increasing crime and mortalities.

An alternative specification of reverse causality involving lags and leads provides a third robustness check. Reverse causality would imply that crime in the current period affects store closings in that period and perhaps later, but not earlier. The hypothesis that video games affect crime implies that gaming in the current period affects crime in that period and perhaps later, but not earlier. Thus, an effect from lead games on crime should capture reverse causality but an effect from lagged games on crime should capture the hypothesized gaming effect. I include only a single lead and lag because I lose two years out of eleven years of data. Table 6 reports that both leads and lags tend be negative. In particular, consistent with reverse causality, the lead of

robberies, burglaries and motor vehicle thefts has a strong negative effect on the number of video game stores. Still, consistent with the above estimates, lagged video game stores has a significant negative effect on motor vehicle thefts and mortalities. Again, these findings are not consistent with video games increasing crime and mortalities.

6. Conclusion

A. Summary of Results

Much of the related psychological literature finds evidence consistent with violent video game play leading to subsequent violent or antisocial behaviors. An implication consistent with these findings would be that crime, especially violent crime, would increase in areas where gaming has become more popular. Instead, across all specifications, I found a negative relationship with a proxy for increased video game play. Similar proxies for other youth activities, sports and movies, show smaller effects or no effects. These effects are larger where the youth population is larger, are independent of county-specific trends, and the timing is consistent with a causal flow from gaming to violence. Moreover, the negative relationship with crime outcomes is reflected in a negative relationship with mortality outcomes. At a minimum, these results are not consistent with video game play leading to increases crime and mortality and are suggestive of leading to decreases in crime and mortality .

Decreased crime and mortality rates can be reconciled with the results from psychological laboratory experiments. Those results indicate that playing violent games heightens physical reactions and affects gamers' attitudes in ways consistent with violent behavioral changes. Three possible effects could explain why, never-the-less, fewer violent

behaviors result. First, it is possible that experiences within video game play substitute for the experiences outside of video game play. The responses measured after video game play would be similar to the responses from the actual experience. However, the gamer may choose to experience them within the gaming environment precisely because it is more socially acceptable. Second, even if there is a violent behavioral change that occurs due to video game play, the time spent while playing the games substitutes for time spent in other activities. This "voluntary incapacitation" effect would be similar to that found by Dahl and DellaVigna (2009). If the activities gaming replaces include some that are more violent than gaming, then the net of the behavioral and incapacitation effects could be fewer adverse events. Third, and relatedly, those who are more tend to commit violent acts could play video games disproportionately more often. The simulated behaviors in video games could be more attractive to those who with the actual behaviors leading to reversed causality from violence behaviors to video game play. Unless selection into video game play is adequately addressed, one might incorrectly associate violent behaviors with video game play (Ward, 2010).

B. Limitations

Because the proxy variable, game stores, does not distinguish between violent and non-violent game play it is difficult to draw strong policy conclusions. This variable is best interpreted as a proxy for typical game play including both violent and non-violent games. It is possible that violent video game play directly causes violent behaviors, but that non-violent video game play substitutes away from even more violent behaviors. If so, it is possible that limiting violence in video games without affecting non-violent games would decrease crime and

mortalities further. However, plausible crime reducing effects from non-violent games suggest that the crime increasing effect from violent games would likely be small. Moreover, imperfect policy implementation would likely reduce some non-violent game play as well as violent game play. Helpful future research would devise a strategy to relate outcomes reflecting crime or violence to the violent content of the games being played. Similarly, more disaggregated outcome data could be employed to determine if the effects found here are in fact confined to the violent video game playing population.

Another weakness is that the analysis does not identify the source in the variation in video game intensity across counties. That is, exogenous variation in the key variable of interest has not been identified and the results could be the result of reverse causality. Various robustness checks were conducted that suggest that the results are not solely due to reverse causality. Still, a conservative interpretation is that there is a negative correlation that may or may not reflect a causal reduction in crime due to video game play. In this sense, the results are similar to many of the psychological studies that find a positive correlation between video game play and violence in survey data.

C. Policy Implications

Appropriate policy toward video game violence is predicated on a positive relationship between violent video game play and illicit behaviors. Rather than arguing for policies aimed at limiting video game play, taken literally, these results might suggest a policy of Pigovian *subsidies* for video game play. However, these results, while indicative, are not definitive. Moreover, any possible unintended consequences of policy to encourage, or discourage, video

game play would have to be assessed prior to making a recommendation. Subject to the above limitations, these results mainly serve to cast doubt on the desirability of policies to restrict video game play.

An additional potential justifications for restrictions on the video game industry is that some parents and community members may simply find these games offensive. For personal reasons, and Independent of any externality, parents may simply wish to restrict their children from playing certain games just as parents tend to restrict their children's access to other objectionable media and activities. If so, an appropriate policy would provide responsible adults with a simple mechanism for restricting offensive material from children. The current video game rating system is one such mechanism that, without restricting access of these games to adults, serves this purpose, although it appears to imperfectly do so (Walsh and Gentile, 2001).

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Table 1
Total US Game Software Sales

Year	Sales ($billions)	Units (millions)
1996	$2.0	74
1997	$3.7	108
1998	$4.8	153
1999	$5.5	185
2000	$5.6	197
2001	$6.1	211
2002	$7.0	226
2003	$7.1	241
2004	$7.4	250
2005	$7.0	230
2006	$7.4	242
2007	$9.5	268
2008	$11.7	298

Source: The Entertainment Software Association <http://www.theesa.com/facts/pdfs/ESA_EF_2009.pdf>

Table 2
Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Murders	4,387	26	85.4	0	1,678
Rapes	4,387	119.2	217.1	0	3,188
Robberies	4,387	765.2	2,596.60	0	56,116
Aggravated Assaults	4,387	1,351.10	3,861.60	0	77,026
Burglaries	4,387	3,029.50	5,754.10	0	104,011
Larcenies	4,387	9,623.40	16,347.30	0	236,758
Motor Vehicle Thefts	4,387	1,997.80	5,652.30	0	113,027
Arson Events	4,387	131.8	356.5	0	6,922
All Mortalities	4,387	3,035.00	4,749.80	220	62,747
Mortalities aged 10-25	4,123	48.5	93.4	3	1,635
Mortalities from Injuries	4,387	190.5	323.2	13	5,212
Game Stores	4,387	15.6	23.6	1	307
Sporting Goods Stores	4,387	30.9	43.5	1	544
Movie Theaters	4,387	7.2	13.8	1	262
Population	4,387	371,333	653,738	49,476	9,917,331
Percent Aged 15-25	4,387	14.4	3.9	7.5	40.7
Earnings per Capita	4,387	11,016	6,313	1,425	105,373
Unemployment Rate	4,387	5.2	1.1	2.2	8.8
Police per 1,000 Pop.	4,387	0.2	0.8	0	15.7

Table 3
Poisson Regression Results of Crime Rates and Mortalities

	Murder	Rape	Robbery	Aggravated Assault	Burglary	Larceny
Ln Game Stores	-0.069	0.016	-0.164	-0.037	-0.087	-0.040
	(0.067)	(0.023)	(0.047)**	(0.027)	(0.024)**	(0.016)*
Ln Movie Theaters	0.101	0.033	-0.019	0.000	0.005	0.015
	(0.077)	(0.022)	(0.040)	(0.022)	(0.019)	(0.015)
Ln Sporting Goods Stores	-0.006	-0.031	-0.141	-0.028	-0.041	-0.043
	(0.083)	(0.033)	(0.065)*	(0.040)	(0.025)	(0.025)$^{+}$
Ln Population	0.331	0.949	1.794	0.556	1.047	0.917
	(0.259)	(0.184)**	(0.238)**	(0.182)**	(0.132)**	(0.122)**
Fraction Aged 15-25	-0.009	0.063	0.019	0.031	-0.011	0.008
	(0.019)	(0.009)**	(0.015)	(0.013)*	(0.009)	(0.007)
Ln Earnings	0.189	-0.174	0.174	0.015	-0.011	0.096
	(0.313)	(0.073)*	(0.115)	(0.087)	(0.059)	(0.049)*
Unempl. Rate	-0.019	0.018	0.094	0.019	0.077	0.043
	(0.026)	(0.008)*	(0.011)**	(0.011)$^{+}$	(0.008)**	(0.006)**
Ln Police Officers t-1	-0.020	-0.009	-0.024	0.012	-0.009	-0.007
	(0.024)	(0.008)	(0.012)$^{+}$	(0.009)	(0.007)	(0.005)
Observations	4,265	4,177	4,278	4,278	4,278	4,278
Number of Counties	471	462	473	473	473	473

Standard errors in parentheses. $^{+}$ significant at 10%; * significant at 5%; ** significant at 1%.
All specifications include unreported fixed county and year effects.

Table 3 (cont.)
Poisson Regression Results of Crime Rates and Mortalities

	Motor Veh. Theft	Arson	All Mortalities	Mortalities Aged 10-25	Mortalities from Injuries
Ln Game Stores	-0.182	-0.227	-0.015	-0.030	-0.036
	(0.050)**	(0.077)**	(0.006)*	(0.018)$^{+}$	(0.012)**
Ln Movie Theaters	0.043	0.010	0.002	-0.010	-0.008
	(0.034)	(0.057)	(0.004)	(0.016)	(0.012)
Ln Sporting Goods Stores	-0.050	-0.091	-0.001	0.000	-0.001
	(0.064)	(0.115)	(0.007)	(0.026)	(0.016)
Ln Population	1.530	1.163	0.826	0.866	0.857
	(0.208)**	(0.521)*	(0.029)**	(0.110)**	(0.083)**
Fraction Aged 15-25	0.039	0.017	0.014	0.039	0.014
	(0.016)*	(0.026)	(0.002)**	(0.007)**	(0.005)**
Ln Earnings	0.116	-0.271	-0.016	0.220	0.048
	(0.133)	(0.198)	(0.026)	(0.062)**	(0.045)
Unempl. Rate	0.073	0.021	0.010	0.011	0.031
	(0.013)**	(0.020)	(0.003)**	(0.009)	(0.008)**
Ln Police Officers t-1	-0.001	-0.014	-0.001	-0.010	-0.007
	(0.016)	(0.026)	(0.003)	(0.007)	(0.005)
Observations	4,278	4,274	4,371	4,101	4,371
Number of Counties	473	471	483	474	483

Standard errors in parentheses. $^{+}$ significant at 10%; * significant at 5%; ** significant at 1%. All specifications include unreported fixed county and year effects.

Table 4
The Impact of Game Stores on Crime and Violence
with Youth Population Interaction

	ln(Game Stores)		Fraction Aged 15-25		ln(Game Stores) x Fraction Aged 15-25	
	coef.	s.e.	coef.	s.e.	coef.	s.e.
Murders	0.056	(0.453)	0.002	(0.019)	-0.009	(0.044)
Rapes	-0.033	(0.218)	0.059	(0.009)**	0.005	(0.022)
Robberies	1.377	(0.380)**	0.054	(0.016)**	-0.138	(0.036)**
Aggravated Assaults	0.294	(0.251)	0.037	(0.012)**	-0.031	(0.025)
Burglaries	0.836	(0.219)**	0.004	(0.008)	-0.087	(0.022)**
Larcenies	0.209	(0.154)	0.013	(0.006)*	-0.023	(0.015)
Motor Vehicle Thefts	0.438	(0.352)	0.051	(0.017)**	-0.055	(0.035)
Arson Events	0.997	(0.667)	0.033	(0.025)	-0.114	(0.068)$^{+}$
All Mortalities	0.227	(0.065)**	0.018	(0.003)**	-0.023	(0.007)**
Mortalities aged 10-25	0.371	(0.155)*	0.045	(0.008)**	-0.038	(0.015)*
Mortalities from Injuries	0.360	(0.151)*	0.020	(0.006)**	-0.038	(0.015)*

Each row reports the coefficients of Game Store and Youth variables from a Poison regression.
Standard errors in parentheses. $^{+}$ significant at 10%; * significant at 5%; ** significant at 1%.

Table 5
The Impact of Game Stores on Crime and Violence
with County-Specific Time Trend

	ln(Game Stores)		ln(Movie Theaters)		ln(Sports Stores)	
	coef.	s.e.	coef.	s.e.	coef.	s.e.
Murders	-0.042	(0.029)	0.044	(0.021)*	-0.034	(0.040)
Rapes	-0.032	(0.028)	0.011	(0.020)	-0.084	(0.038)*
Robberies	-0.023	(0.029)	0.035	(0.020)$^{+}$	-0.015	(0.040)
Aggravated Assaults	-0.024	(0.034)	0.029	(0.024)	-0.147	(0.047)**
Burglaries	-0.060	(0.037)	0.022	(0.026)	-0.078	(0.051)
Larcenies	-0.046	(0.043)	0.016	(0.030)	-0.090	(0.059)
Motor Vehicle Thefts	-0.076	(0.032)*	0.024	(0.023)	-0.057	(0.045)
Arson Events	-0.182	(0.041)**	0.015	(0.029)	-0.086	(0.056)
All Mortalities	-0.001	(0.003)	0.007	(0.002)**	0.010	(0.004)**
Mortalities aged 10-25	0.017	(0.014)	0.012	(0.009)	0.004	(0.019)
Mortalities from Injuries	0.002	(0.008)	0.015	(0.006)*	-0.004	(0.012)

Each row reports the coefficients from an linear regression of Ln(Outcome per capita). All variables are calculated as differences from county-specific trends. Standard errors in parentheses. $^{+}$ significant at 10%; * significant at 5%; ** significant at 1%.

Table 6
The Impact of Game Stores on Crime and Violence
with Lags and Leads

	ln(Game Stores) lagged one year		ln(Game Stores)		ln(Game Stores) lead one year	
	coef.	s.e.	coef.	s.e.	coef.	s.e.
Murders	0.018	(0.068)	-0.001	(0.065)	-0.062	(0.086)
Rapes	-0.015	(0.037)	0.026	(0.037)	0.025	(0.033)
Robberies	0.020	(0.050)	-0.035	(0.052)	-0.207	(0.054)**
Aggravated Assaults	0.055	(0.038)	-0.028	(0.041)	-0.041	(0.039)
Burglaries	-0.014	(0.026)	-0.027	(0.027)	-0.083	(0.025)**
Larcenies	0.002	(0.021)	-0.015	(0.022)	-0.025	(0.023)
Motor Vehicle Thefts	-0.093	(0.047)*	-0.019	(0.048)	-0.178	(0.047)**
Arson Events	-0.057	(0.103)	-0.082	(0.113)	-0.153	(0.110)
All Mortalities	-0.012	(0.006)$^{+}$	-0.003	(0.005)	-0.013	(0.006)*
Mortalities aged 10-25	-0.027	(0.021)	0.012	(0.022)	-0.028	(0.024)
Mortalities from Injuries	-0.014	(0.013)	-0.019	(0.017)	-0.020	(0.016)

Each row reports the coefficients of Game Store variables from a Poison regression. Bootstrapped standard errors in parentheses. $^{+}$ significant at 10%; * significant at 5%; ** significant at 1%.

1.See <http://theesa.com/facts/top_10_facts.php>.

2.See the description of ESRB ratings at <http://www.esrb.org/ratings/>.

3.Alternative specifications regressing the logarithm of the crime rate calculated as the number of crimes per capita yield similar results.

4. The market research firm NPD Group regularly reports the top 20 selling games each month. In a typical month, about one-third of these games will be new releases displacing one-third of the previous month's top 20 sellers.

5.Below, I test for a possible area-specific time-trending omitted variable.

6.See US Census Bureau. http://www.census.gov/epcd/cbp/view/cbpview.html.

7.See US Census Bureau. http://www.census.gov/popest/datasets.html.

8.See US BLS http://www.bls.gov/.

9.See the FBI's UCR data available at Inter-University Consortium for Political and Social Research (ICSPR) http://www.icpsr.umich.edu/NACJD/ucr.html.

10.See <http://wonder.cdc.gov/>

11.The cause of death from "external causes of injuries or poisonings" correspond to ICD-9 disease codes E800-E999 for years 1994 to 1998 and ICD-10 codes V01 to Y89 for years 1999 to 2004.

12.The non-parametric bootstrap method is used.

13.See <http://www.ojp.usdoj.gov/bjs/glance.htm#Crime>.

14.The video game results are robust to the inclusion or exclusion of the sporting goods stores and movie theaters variables.

15.These differences are statistically significant for burglaries, larceny and arson.

16.The number of game stores grew at a smaller pace than did video game sales. This is due, in part, to a general increase in the importance of individual game stores as they have increased in size as indicated by the change in the number of employees per store. Unreported regressions are consistent with a larger (in absolute value) game store effect over time as game stores became larger.