UNDERSTANDING THE EFECTS OF

VIOLENT VIDEO GAMES ON VIOLENT CRIME

A. Scott Cunningham, *Baylor University*

Benjamin Engelstätter, *Zentrum für Europäische Wirtschaftsforschung*

Michael R. Ward, *University of Texas at Arlington*

Corresponding Author:
Michael R. Ward
Associate Professor
Department of Economics
University of Texas at Arlington
Arlington, TX 76019
(tel) 817-272-3090
(fax) 817-272-3145
mikeward@uta.edu

ABSTRACT: Video games are an increasingly popular leisure activity. As many of best-selling games contain hyper-realistic violence, many researchers and policymakers have concluded that violent games cause violent behaviors. Evidence on a causal effect of violent games on violence is usually based on laboratory experiments finding violent games increase aggression. Before drawing policy conclusions about the effect of violent games on actual behavior, these experimental studies should be subjected to tests of external validity. Our study uses a quasi-experimental methodology to identify the short and medium run effects of violent game sales on violent crime using time variation in retail unit sales data of the top 50 selling video games and violent criminal offenses from the National Incident Based Reporting System (NIBRS) for each week of 2005 to 2008. We instrument for game sales with game characteristics, game quality and time on the market, and estimate that, while a one percent increase in violent games is associated with up to a 0.03% decrease in violent crime, non-violent games appear to have no effect on crime rates.

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I. Introduction

Violence in video games is a growing policy concern. The issue has generated six reports to the US Congress by the Federal Trade Commission (FTC, 2009) and was the subject of a 2011 US Supreme Court decision.[2] Policymaker concern has been motivated by the connection between violent video game imagery and psychological aggression in video game players, particularly adolescents. While researchers have documented an effect on aggression in the laboratory, some have suggested that violent video games are responsible for violent crime such as school shootings (Anderson 2004).[3]

The shortrun effect of violent games on aggression has been extensively documented in laboratory experiments (Anderson, Gentile and Buckley, 2007). These experiments generally conclude that media violence is self-reinforcing rather than cathartic. This link has not been found with crime data however. A recent study by Ward (2011) found a negative association between county-level video game store growth and the growth in crime rates. Dahl and DellaVigna (2009) find that popular violent movies caused crime to decrease in the evening and weekend hours of a movie's release lasting into the following week, with evidence that violent movies were drawing men into theaters and away from alcohol consumption. These two studies suggest the real world relationship between violent media and crime may be more complex than the results from laboratory studies suggest.

We estimate the reduced form effect of violent video games on violent crime using a strategy similar to Dahl and DellaVigna (2009). We proxy for video game play using video game sales information harvested from VGChartz, an industry source tracking the weekly top 50 best-selling video game titles from 2005 to 2008.[4] The violent content for each video game was matched using information provided by the Entertainment Software Rating Board (ESRB).[5] Our

measure of crime is from the National Incident Based Reporting System (NIBRS) which we use to create a time series of violent and non-violent crime levels for the periods in question. To address possible endogeneity of game releases with unobserved determinants of crime, such as the coincident release of non-gaming violent media, we instrument for weekly game sales with game characteristics, such as time a game has been on the market and experts' reviews of each game in our sample using Gamespot, a video game review aggregation website.[6] Our identification strategy requires game quality to be uncorrelated with the unobservable determinants of crime.

Our main finding is that we do not find evidence for a positive effect on crime. Our most robust evidence supports the opposite conclusion for a negative effect of violent games on crime. Our basic 2SLS results indicate that violent crimes fall with violent video game popularity but are virtually unaffected by changes in weekly non-violent video game sales. These results are not consistent with games causing aggression but are consistent with either violent games having a cathartic or an incapacitation effect. We estimate the elasticity of violent crime with respect to violent game sales to be small, on an order of –0.01 to –0.03.

The rest of our paper is organized as follows: Section II provides background; Section III describes our data and empirical strategy; Section IV describes our empirical findings; and Section V concludes.

II. Background

From the sensational crime stories of the 19th century (Comstock and Buckley 1883), to the garish comic books of the early 20th century (Hadju 2009), to the contemporary debate over

violent games, Americans have always been concerned about the harmful effects of violent media on children. Unlike comic books and pulp "true crime" stories, violence in media, including video games, have received substantial attention by psychologists and media specialists. Anderson and Bushman (2001) and Anderson et al. (2007) discuss hundreds of controlled studies on the effects of violence in media, whereas the number of studies on violence in print media is particularly smaller in comparison.

The impact of violent media on crime has three possible theoretical mechanisms, which we label "aggression," "incapacitation," and "catharsis." The aggression mechanism is based on a psychological theory called the "general aggression model," or GAM. GAM posits that violent video games increase aggressive tendencies. This model generalizes from social learning theory (Bandura, 1973), script theory (Huesmann, 1998), and semantic priming (Anderson et al., 1998; Berkowitz & LePage, 1967) through a process of social learning whereby the gamer develops mental scripts to interpret social situations both before they occur as well as afterwards. This effect creates reasoning biases, a tendency to jump to conclusions and may even cause personality disorders (Bushman and Anderson 2002).[7] While GAM suggests that aggression increases with repeated exposure to violent content, most of the evidence for it comes from short-run laboratory experiments.

The incapacitation explanation is based on the economic theory of time use (Becker 1965). Many modern video games are time-intensive forms of entertainment involving intense narratives with complex plots and characterization taking dozens, and sometimes several hundreds, of hours to complete.[8] Insofar as video game play draws adolescents from other activities, the time use explanation implies a short-run decrease in violence as individuals substitute away from outdoor leisure to indoor leisure, but allow for a possible long-run increase

in violence as predicted by GAM. The American Time Use Survey (ATUS) indicates that individuals aged 15-19 spent an average 0.85 hours per weekday playing games and using computers, but only 0.12 hours reading, 0.11 thinking, and 0.67 in outdoor recreation, such as sports or exercising. Ward (2012) uses ATUS data to show that, when the currently available video games' sales are higher, individuals' time spent gaming increases significantly while time spent in class or doing homework falls. Stinebrickner and Stinebrickner (2008) found that students randomly assigned a roommate in college with a video game console caused them to study less often, and in turn, perform worse in school.

The catharsis explanation is that video games act as a release for aggression and frustration so that actual expressions of aggression are reduced. While gamers believe this to be true (Ferguson et al., 2010; Olson et al., 2008), it is not without controversy. Most cross-sectional studies fail to find cathartic effects, but none control for selection on unobservables. Denzler et al. (2008) state rather unequivocally that "social psychological literature lends no support for the catharsis hypothesis." They then find that aggression can reduce further aggression when it serves to fulfill a goal but caution that these results "do not justify violent media." A possible physiological mechanism for catharsis comes from evidence that Internet video game playing is associated with dopamine release that might act to sate the gamer (Han et al., 2007; Koepp et al. 1998). Han et al. (2009) study the similarity of the effects of video game playing and methylphenidate (i.e., Ritalin) in children with ADHD and suggest that Internet video game playing might be a means of self-medication.

III. Data and Methodology

The three explanations have different implications for the effects of violent video games on violent crime. GAM predicts that crime would increase with greater exposure to violent video games, especially continuous exposure over long time periods, but not with non-violent games. While GAM should have long-run effects, to date, most evidence comes from short-term experiments. Incapacitation predicts that crime would decrease in the shortrun with both violent and non-violent games, perhaps more so for non-violent games not subject to GAM. Catharsis predicts that crime, especially violent crime, would decrease with violent games, but not with non-violent games. In this section, we explain how we specify tests for these predictions and the data sources we employ.

A. Estimation Strategy

We begin by estimating a standard multivariate regression model of the incidence of various crimes as functions of, among other controls, the prevalence of non-violent and violent video games. Our outcome variables of interest, C_t, are the total number of reported criminal incidents in week *t* that are classified as violent or non-violent. Any criminal incident may reflect some level of aggression, but we interpret violent crimes as reflecting more aggression than non-violent crimes. While the dataset we use documents criminal offenses on a daily basis, since the video game sales data are available only on a weekly basis, we aggregate crimes into weekly measures to avoid double counting of responses to stimuli. Accordingly, we employ a simple least squares estimator so as to more easily instrument for video game exposure.[9]

A game purchased by a gamer in one week is often played in subsequent weeks until the gamer loses interest and moves on to another game. To address this possibility, we experimented

with the effect of game sales on crime for up to a lag of six-weeks. Our main explanatory variables are aggregated current and lagged values of weekly sales volumes for both non-violent and violent video games. Video games appear to depreciate quickly with use. This may be because new games are played intensively for a few weeks after purchase and are not replaced with a new game until after some diminishing returns have been reached, or it may suggest that firms typically stagger the release dates of games. Given that we do not know the relative intensity of game play after game purchase, we do not have strong priors on the pattern of coefficients on these lags. We focus on the cumulative effect of games measured with the volume of the current week's sales, along with the various lags of previous weeks' sales, so as to capture the effect of higher volume of game play with varying time lag to trigger crime.

Our model of criminal offenses, C_t, is:

$$C_t = \sum_{\tau} \beta_v^{\tau} G_{t-\tau}^{v} + \sum_{\tau} \beta_{nv}^{\tau} G_{t-\tau}^{nv} + \sum_{w} \beta^{w} week_t + \beta_y year_t + \varepsilon_t.$$

The number of crime incidents depends on the exposure to violent video game sales G_t^v and non-violent games G_t^{nv}. The sum over τ of β_v^{τ} can be interpreted as the cumulative increase in criminal incidents over the τ weeks for an increase in violent video games sold in week *t* while the similar sum for β_{nv}^{τ} can be similarly interpreted for non-violent video games. We include an annual trend and weekly seasonal fixed effects to account for secular increases and seasonality in both video game purchases and crime. Thus, identification of the parameters of interest comes from within week-of-year variation around the linear trend. Because many video games are purchased as Christmas gifts, as a check we also analyze the data omitting this season.

Correlations between video game play and crime may or may not reflect a causal relationship if the unobserved determinants of crime are correlated with the determinants of video game play. For instance, bad weather such as rain or heavy snow which causes individuals to

remain at home would both increase the likelihood of playing video games and decrease the returns to crime through higher chances of finding a resident at home. Hence, negative correlations between crime and violent video game play could purely be a consequence of omitted variable bias. A low opportunity cost of time would affect both video game sales and the relative return to criminal activity (Jacob & Lefgren, 2003). For example, both video game sales and the crime rate increase during the summer when most teenagers are out of school. Additionally, producers of multiple media sources - movies, television, music and video games – may be simultaneously targeting time periods in which consumers have low opportunity costs of time that is unobservable to the researcher. If so, we could be attributing to a causal video game effect what is actually a more general media effect. We address this potential endogeneity of video games using characteristics of video games, time on the market and expert reviews of each title, as an instrument for purchases.

Zhu and Zhang (2010) show that consumer reviews of video games are positively related to game sales. Ratings are valuable pieces of information for video games because games are complex experience goods for which gamers cannot know their preferences without playing. Our data on professional ratings contain rich information that communicates the kinds of information that gamers value in forecasting their beliefs about the game, and as beliefs and anticipation are drivers of the game sales, we would expect these rating institutions to play important roles in forming consumer prior beliefs about the game and therefore their purchases. But we also have some evidence from other industries that would suggest scores would independently cause purchases to rise, independent of the unobserved factors that cause expert opinion and purchases to be highly correlated. Reinstein and Snyder (2005) used exogenous variation in Siskel and Ebert movie ratings due to disruptions in their pair's reviewing to determine a causal effect on movie demand. More recently, Hilger et al. (2010) found that randomly assigned expert scores on

bottles of wine in a retail grocery store caused an increase in sales for the higher rated, but less expensive, wines. While these studies do not confirm that there are exogenous forces in video game ratings that drive consumer purchases, they are suggestive.

Besides the benchmark specification we employ two additional specifications as robustness checks. These specifications identify specific segments of the population and locations where we expect a differential gaming-to-violence link, e.g. counties with a high youth population and crimes committed in proximity of students. We measure criminal incidents using the National Incident Based Reporting System (NIBRS) as it provides detailed information on the criminal offense, including the exact date of the incident, some offender characteristics and the location of the incident. In the first robustness check, we examine how the effect varies by the fraction of the county population that is 15-24 years old. In our second check, we extend our estimation procedure to compare the effects on the number of incidents reported on high school and college campuses to the number committed at other locations.

B. Video Game Data

VGChartz reports US retail video and computer game unit sales for each week's top 50 selling video console based games each week consistently beginning in 2005.[10] We harvested these data using a web-scraping program to create a panel of weekly sales by title for the period from January, 2005 to December, 2008. We matched each game title with information about the game's violent content provided by ESRB's online database. Finally, we matched each game title with information about game quality from a game review website, Gamspot.com.

Our video game sales dataset consists of 1,117 separate titles over 208 weeks with some of these titles being the same game for different gaming consoles. In sum, the games are provided from 47 different publishers and designed for 9 different gaming consoles. While VGChartz

includes the top 50 selling console-based games each week, it only covers a portion of all sales in the US video game market. A game's week of release is almost always its top selling week. Figure 1 indicates that most games stay in the top 50 for only a few weeks. Moreover, as Figure 2 indicates, games sales by title fall quickly with game age. These features suggest that there is considerable week-to-week variation in the composition of video games being played. Table 1 compares VGChartz data to the Entertainment Software Association (ESA) and indicates that VGChartz account for about one-quarter of all units in 2005 (ESA Annual Report, 2010).[11]. The ESA also includes sales of non-console based games such as computer and smartphone games. Still, this fraction rises to almost one-half in 2008. While this raises some concerns about comparability over time, we expect some of this effect to be subsumed into the annual trend.

Insert Table 1 about here

Insert Figure 1 and 2 about here

We record the violence content of each game using the ESRB's rating and descriptions of the game's content. This non-profit body independently assigns a technical rating (E, E10, T, M, and A) which defines the audience the game is appropriate for where E classifies games for everybody, E10 for everyone aged 10 and up, T for teens, M games for a mature audience, and A for adult content. In addition, ESRB provides detailed description of the content in each game on which the rating was made, including the style of violence, e. g. language, violence, or adult themes. For all of the 1,117 titles in our sample we collected the appropriate ESRB-rating and all content descriptors. Based on this content information, we identify 672 non-violent and 445 violent games, of which 113 titles are described as intensely violent. Almost all violent games are rated T or M. All intensely violent games are rated M. Since most of the policy concern stems

from these mature games, we concentrate on the intensely violent games. Merging both data sources together we can construct measures of the aggregate unit sales of non-violent and intensely violent video games for each week. The weekly sales are depicted in Figure 3 for all games and for intensely violent games. Overall, the two graphs follow a similar pattern with a large peak around the Christmas gift-purchasing period. In the middle of 2008, however, the intensely violent game sales spiked to account for almost all sales of the violent games.

Insert Figure 3 about here

Our expert review data comes from the GameSpot website. GameSpot provides news, reviews, previews, downloads and other information for video games. Launched in May 1996 GameSpot's main page has links to the latest news, reviews, previews and portals for all current platforms. It also includes a list of the most popular games on the site and a search engine for users to track down games of interest. The GameSpot staff reviewed all but a handful of the games in our sample and rated the quality of the titles on a scale from 1 to 10 with 10 being the best possible rank. These so-called GameSpot-scores assigned to each game are intended to provide an at-a-glance sense of the overall quality of the game. The overall rating is based on evaluations of graphics, sound, gameplay, replay value and reviewer's tilt. GameSpot changed the rating system in the middle of 2007 and, as a consequence, a game will not get an aspect-specific rating score anymore. Our examination of overall GameSpot-scores indicates that they were unaffected by this change in the GameSpot focus. Weekly sales of individual games are highly sensitive to both game quality and time on the market (Nair, 2007). Accordingly, we separately aggregate the violent and non-violent games among top 50 games on the market in a

week into average GameSpot-scores and average ages, measured in weeks from release, to be used as instrumental variables.

C. Crime Data

For our measure of weekly crime, we used the NIBRS. NIBRS is a federal data collection program begun by the Bureau of Justice Statistics in 1991 for gathering and distributing detailed information on criminal incidents for participating jurisdictions and agencies. Participating agencies and states submit detailed information about criminal incidents not contained in other data sets, such as the Uniform Crime Reports. For instance, whereas the Uniform Crime Reports contain information on all arrests and cleared offenses for the eight Index crimes, NIBRS consists of individual incident records for all eight index crimes and the 38 other offenses (Part II offenses) at the calendar date and hourly level (Rantala and Edwards 2000).

Because of the detailed information about the incident, including the precise time and date of the incident, economists such as Dahl and DellaVigna (2009), Card and Dahl (2009), Jacob and Lefgren (2003) and Jacob, Lefgren, and Moretti (2007) have used it for event studies. In our case, we exploit detailed information about the crime's location for our robustness checks.

One potential drawback of NIBRS is its limited coverage. Unlike the FBI's Uniform Crime Reports, only a subset of localities participate. Overall, 32 states currently participate, and many states with large markets – California, New York, DC – do not participate at all. Moreover, not all jurisdictions participate within states over time. To address possible selection problems, we limit our sample to a balanced panel of agencies that participated with NIBRS at the start of our sample and continued each year.

Crimes follow a seasonal pattern. Figure 4 indicates a consistent pattern of gradual increases in both total and violent crimes from winter to summer. Our method was developed to account for seasonality in both of our main variables of interest crime and games. Much of the seasonality in crimes is believed to be due to weather while seasonality in games is likely due to holiday gift giving (Lefgren, Jacobs and Moretti, 2007). Failure to address these may create spurious correlations between crime and video game sales. As indicated above, we accommodate this in two ways. First, weekly dummy variables should capture much of the seasonality. Second, we use IVs constructed from information on games' Game Spot Scores as well as how long games have been on the market to isolate the variation in game sales solely due to the characteristics of the currently available video games.

Insert Figure 4 about here

D. Final Sample

Our final sample includes 208 weekly observations on video games sales and crimes from early 2005 through 2008. However, four observations are excluded from final regressions because of the use of lagged video game sales. Table 2 reports basic descriptive statistics for our sample.

Insert Table 2 about here

Our method is most like Dahl and DellaVigna (2009), and therefore we contrast our study to illustrate its strengths and weaknesses. Like Dahl and DellaVigna (2009), we do not have geographic variation in sales data. Whereas first run movies can be described as non-durables

lasting two hours on average, video games are more complex. Unlike feature films, they are durable goods, being played repeatedly after purchase with actual time use being highly variable both by title and individual player. Some families budget time allowances for video game play, while others allow unlimited play time. The time use decision to do so is likely related to the family characteristics that are correlated with the determinants of crime, such as family structure and income. Furthermore, box office movie sales are available by day whereas video game data are only available at the weekly level. Hence one of the reasons we favor our instrumental variables strategy is that it provides greater confidence in the results by exploiting the variation in game characteristics to identify exogenous variation in weekly game sales.

IV. Results

Figure 5 demonstrates the challenges faced by our methodology. When "Grand Theft Auto IV" was released in on April, 29, 2008 it sold over two million units in its first week. This was double the weekly sales of any other intensely violent video game in our sample and raised sales of intensely violent games that week to ten times the sample average (see figure 3 also). Yet, even with this massive "stimulus," it is not clear that there was a subsequent "response" in the number of crimes. Any actual effects are likely to be so small that they are not revealed by individual events, even large ones.

Insert figure 5 about here

Before proceeding to estimation results, we first conduct tests confirming the stationarity of the relevant data series after detrending and deseasonalizing each series. We conduct

Augmented Dickey-Fuller (ADF) tests for a unit root with four lags. The lag length was chosen using the Schwarz's Bayesian Information Criterion (SBIC) for various lag lengths. As table 3 reports, we can reject a unit root for the four series representing crimes and video game sales.

Insert table 3 about here

A. Basic Results

Our basic OLS regression results are presented in Tables 4. Table 4 reports estimates of specifications for four lags of the effect of video games sales, measured in thousands, on violent crimes and on all crimes. Video games are separated between those that the ESRB rated as "intensely violent" and those that are not. Recall that the lesser rating of merely "violent" does not warrant an ESRB rating of "Mature."[13] Control variables include 52 weekly dummies to capture seasonality and a year trend to capture a possible spurious correlation due to an upward trend in games sales and a downward trend in crime. The specification reported here includes four lags of game sales. Higher order lags failed to achieve significance but specifications with either more or fewer lags generated similar overall results. While the non-violent video game sales variables display no obvious pattern, those for violent video games are all negative.

With this this many lags and with lag values possibly being correlated, we do not expect to be able to distinguish the effect of one week from the next. Instead, we concentrate on the cumulative effect over all lags. F tests for the cumulative effect over all four lags, reported in the first two columns of the top panel of table 5, indicate that violent games are associated with reductions in both the violent and all crime outcome measures. These effects are consistent only

with the hypothesized cathartic effect from violent video games. However, the estimated effect is small, implying an average elasticity of crime with respect to violent games of about -0.01.

Insert Tables 4 and 5 about here.

B. Results without the Christmas season

One concern is that the lag structure from purchase to playing to effects on crime will differ during the Christmas gift-giving season. Many purchases made weeks before Christmas will not be played until after Christmas. This is above and beyond the seasonality shift effects we expect the weekly dummy variables to capture. To address this, we re-estimate the basic model but omit the last four weeks and first two weeks of the calendar year. Rather than report coefficients of all lag values, we report the cumulative effects in the bottom panel of table 5. These results are not very different from those that include the Christmas season.

C. Instrumental Variable Results

As mentioned above, it could be possible that the release of different types of games coincides with other possible factors affecting crime. For example, demand for various multiple media may be higher during periods when the target audience has low opportunity cost of time not accounted for by seasonality. If so, the actual effect on crime may be due to an omitted variable and not playing video games. To attempt to address this issue, we repeat our analysis with a 2SLS estimator using average game quality and time on the market as instruments. In this way the variation in video game sales will be related to these product characteristics and not

necessarily to demand side factors. With four lags of two variables, we instrument for eight endogenous variables. Table 6 reports first stage results for video game sales lagged 1 week. For both violent and non-violent games, while some other lags may be significant, increases in contemporaneous average quality and age tend to significantly increase and decrease sales respectively.[14] Table 7 indicates significant variation in all eight endogenous variables emerging from the instruments.

Table 8 reports the second stage results to the same specification as the OLS regressions in table 4. Note that Sargan's statistic fails to reject the null hypothesis that the instruments are valid. These results generate a pattern similar to the OLS results of table 4, but generally with larger, in absolute value, coefficient estimates. The cumulative effects are reported in the right two columns of table 5, both including and excluding the Christmas season. These indicate that violent video games are associated with reductions in crimes but non-violent video games have no effect. The implied elasticity of crime with respect to violent video game sales is now -0.015 to -0.028, a larger reduction in crime from violent video game sales than the OLS estimates indicate.

Insert Tables 6, 7 and 8 about here.

D. Results by County Youth Population

A potential robustness check is to test for differential effects of video games on criminal offences by the age profile of an area. While the age profile of video game players is increasing, video games are still primarily played by children, teens and younger adults and not more mature adults. If younger people play more video games then areas with higher concentrations of

younger people should be more affected by video game playing. We distinguish between areas with high or low concentrations of potential video game players by calculating the fraction of each county's population aged between 15 and 25. We separate the counties with a fraction above the mean of 14.1% from those with a fraction below the mean. Under the assumption that this age group plays video games more, our model should find that the measured effects will be larger for counties with a high youth population.

The results of this robustness check are reported in table 9. This table reports results from the 2SLS estimator but the OLS results are qualitatively similar. Except for disaggregating the dependent variables by age profile, the specification is identical to that of table 8. Moreover, across all columns, the overall results are similar to those from table 8. The key difference is the magnitude of the implied elasticities of violent video games on crime for the low youth versus high youth counties. For violent crimes, the reduction in crimes when violent video game demand is high is about 60% higher in high youth counties. However, for all crimes, the reduction in crimes when violent video game demand is high is about 40% lower in high youth counties. Thus, this robustness check yields mixed results.

Insert Table 9 about here

E. On Campus Results

Another potential robustness check is to distinguish between crimes committed at schools and colleges and those committed elsewhere. Schools and colleges tend to be highly disproportionately populated with people who are of video game playing age. The NIBRS data record the location of each incident as a categorical variable where one possible choice out of

eleven is "school or college campus." One advantage of this variable over using the age profile of the county is that the vast majority of on campus crimes will be committed by the population that disproportionately plays video games. A disadvantage is that many of the younger video gamers also commit crimes away from schools.

Table 10 reports the results of this robustness check. This table also reports results from the 2SLS estimator but the OLS results are qualitatively similar. Again, except for disaggregating the dependent variables by location of the crime, the specification is identical to that of table 8 and the overall results are similar to those from table 8. The robustness test focuses on magnitude of the implied elasticities of violent video games across the two groups. For both violent crimes and all crimes, the reduction in crimes when violent video game demand is about twice as high on campus than off campus. Thus, this robustness check provides further evidence that our basic result is not due to spurious correlations.

Insert Table 10 about here

V. Conclusion

Regulation of the content of video games is usually predicated on the notion that the industry has large and negative social costs through games' effect on aggression. Many researchers have argued that these games may also have caused extreme violence, such as school shootings, because of the abundance of laboratory evidence linking violent media to measured psychological aggression. Yet to date, because the field has not moved beyond suggestive laboratory studies, we argue their external validity to understanding the impact on crime is limited. With the exception of Ward (2011), social scientists have yet to move beyond the

laboratory to understand whether concerns about game violence's causal effect on crime are warranted. Similar to Dahl and DellaVigna (2009) our evidence finds robust evidence that violence in media may even have social benefits by reducing crime. Consistent with these studies, we find that the short and medium run social costs of violent video games may be considerably lower, or even non-existent. The measured effect stemming from only violent video games and not non-violent games is consistent with catharsis and not with incapacitation.

Our results are not completely inconsistent with GAM. Most theories in GAM are related to long term exposure to violent media. Our tests measure only short-term responses to video game violence. It is possible that there exists a long-term GAM effect as well as a short-term cathartic effect. The case for regulatory intervention depends on whether both of these effects apply. While some early work has been done on the long-term effects of video game play, nearly all the laboratory evidence that currently exists has only uncovered very short-term effects.[15]

Our findings also suggest unique challenges to game regulations. GAM proposes that the individuals playing violent video games are developing, accidentally, a biased hermeneutic towards people wherein they believe they are in danger. It is possible that the decrease in violent outcomes that we observe in our study, possibly due to short-run catharsis, is masking the long-run harm to society if these violent behaviors are developing within gamers. This suggests that regulation aimed at reducing violent imagery and content in games could in the long-run reduce the aggression capital stock among gamers, but potentially also cause crime to increase in the short-run if the marginal player is currently being drawn out of violent activities. This tradeoff may not pass a cost-benefit test.

A related policy question centers on whether reducing violent content of video games so as to diminish GAM related aggression effects also would diminish any time use and cathartic

effects. Presumably, publishers include content that is violent because there is a market niche that demands it. They believe that removing the violence would lower profits because it would reduce these gamers' willingness-to-pay. It is not clear how much time use might fall, but lower utility from such games would reduce game demand and game play time by some amount. The ability to craft a regulation restricting violent content that does not also lower consumer utility seems remote.

Using our approach we find a negative inelastic relationship between weekly non-violent video game sales and weekly crime of no more than –0.03. As our research design exploits shortrun variation in weekly sales up to a four week lag, caution should be used in applying it outside our sample frame. For instance, if behavioral effects from popular, higher quality games diverge from that of popular, lower quality games, then our approach may misstate the average elasticity of games independent of quality. Furthermore, our elasticity is exclusively based on shortrun variation in sales, which may be different from effects in the longrun. For instance, the substitution out of schooling to video gameplay as Stinebrickner and Stinebrickner (2008) and Ward (2012) show might imply that longrun effects of violent games on crime are positive by reducing human capital and wages (Grogger 1998). With this caveat, we use this elasticity to construct a simple counterfactual for US crimes from 2005 to 2008.

To provide context for the magnitude of our estimated effects, we consider a simple back-of-the-envelope calculation using the numerical growth in video game sales over our sample period. From Table 1, we calculate that video game unit sales increased by an average of 9.6% per year. Assuming this applies to both violent and non-violent games, our estimated violent video game-to-violent crime elasticity of approximately -0.03 would predict almost 0.3% fewer violent crimes per year due to violent video game sales. Nationwide, this would translate to about

10 fewer violent crimes committed per day.[16] By comparison, the estimated incapacitation effect from Jacob and Lefgren (2003) of 13.3% more property crimes due teacher in-service days, would translate into about 2,300 property crimes for a hypothetical national in-service day.[17] Since the video game effect occurs year round, this suggests that there are potentially large social externalities associated with crime that violent games are disrupting in the shortrun.

This approach can help guide investigators to develop more holistic research designs, such as field experimentation and other quasi-experimental methodologies, to determine the net social costs of violent games. The main shortcoming of our approach is due to the limitations of our data on game sales. Unfortunately, the industry does not report cross-sectional variation in game sales – only the national weekly sales of the top 50 highest grossing games are available. As a result, our paper follows a methodology similar to Dahl and DellaVigna (2009), who estimated the impact of violent movies, as proxied by daily ticket sales, on crime using only time series methods. These analyses are suggestive of the hypothesis that violent media paradoxically may reduce violence in the short-run while possibly increasing the aggressiveness of individuals in the long-run.

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Figure 1

Number of Weeks a Game is in the Top 50 Sellers

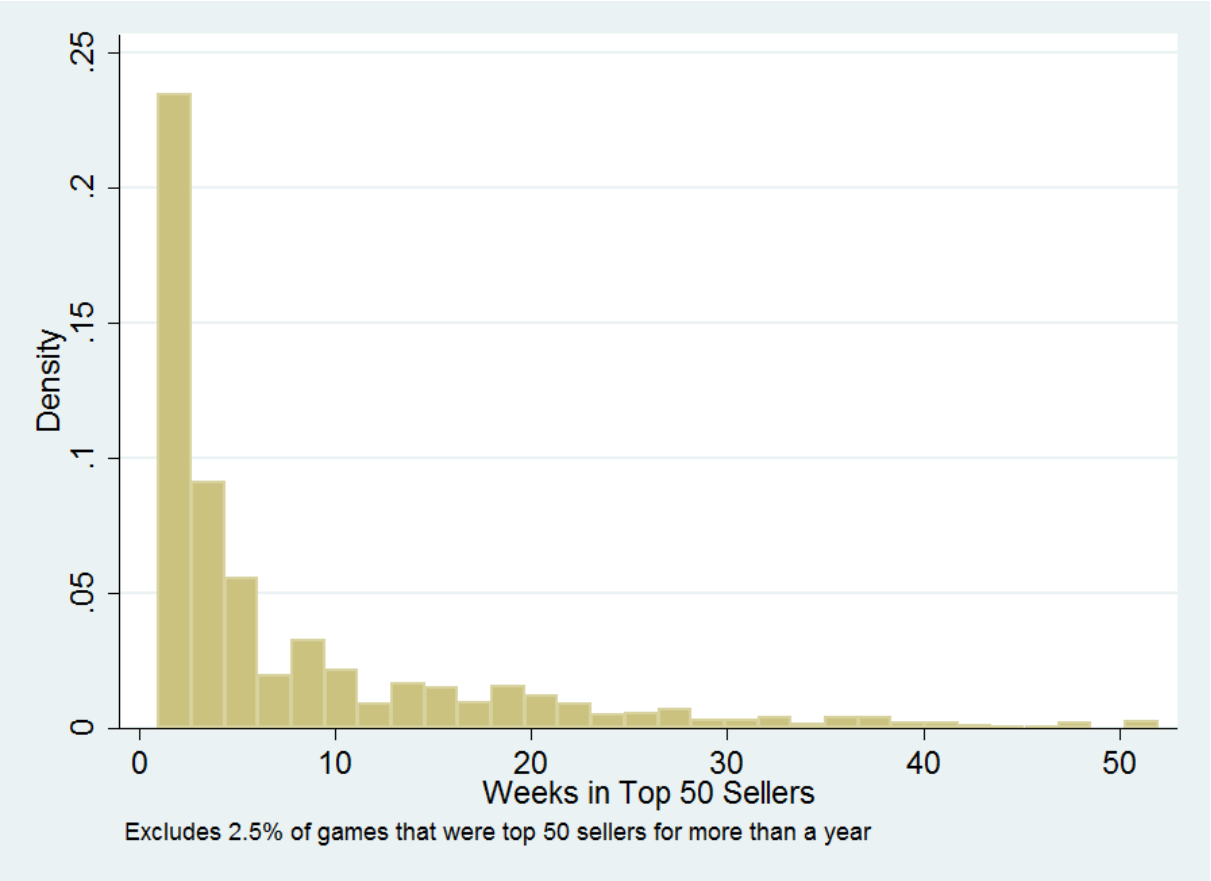

Figure 2

Average US Video Game Unit Sales by Weeks after Release

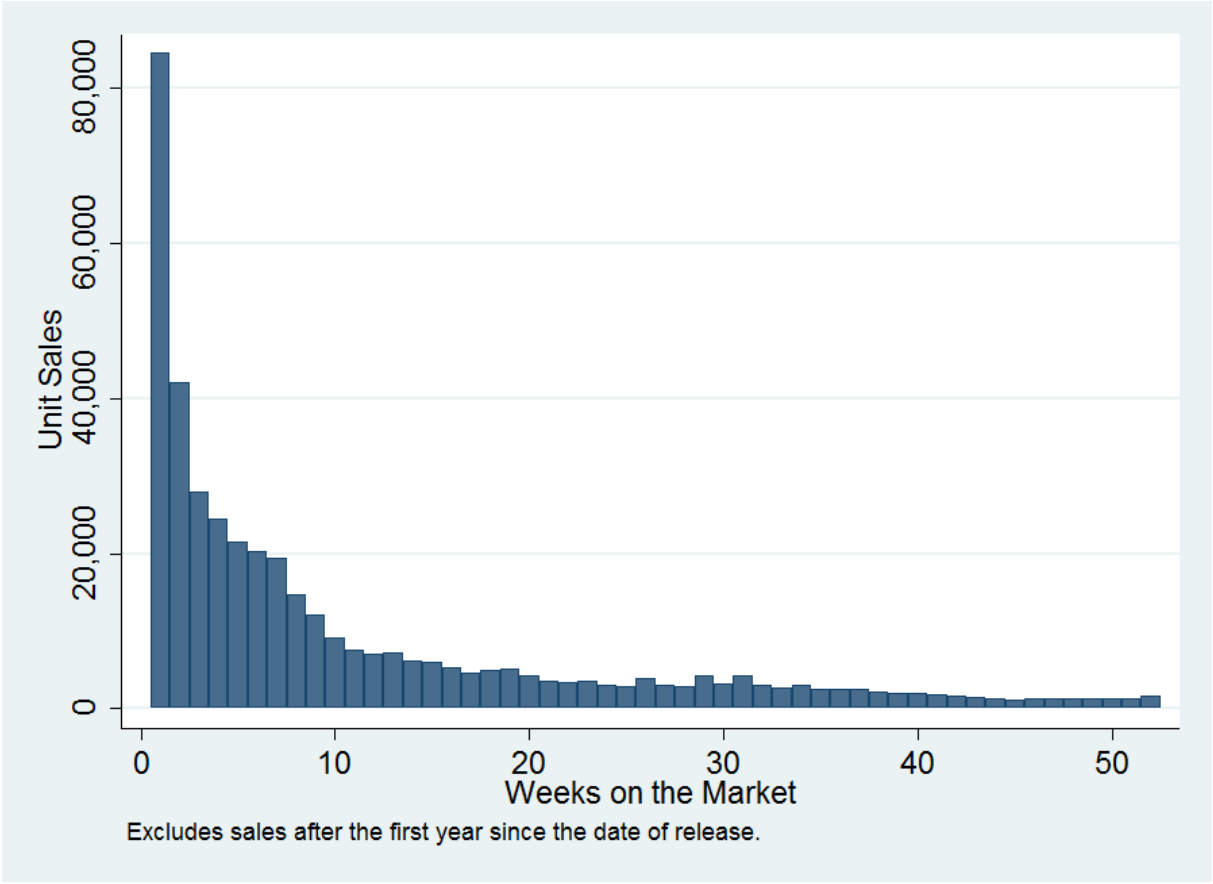

Figure 3

Weekly Sales of Video Games

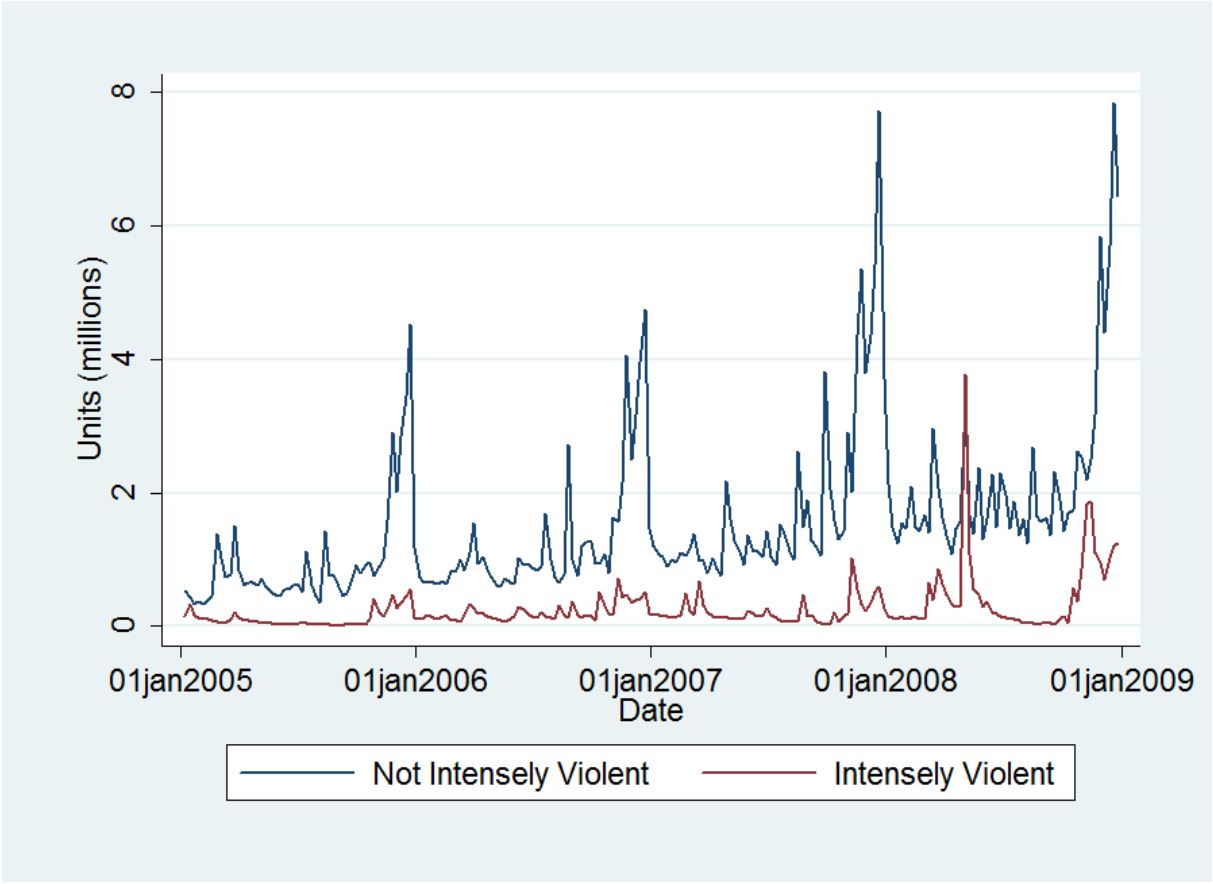

Figure 4

Total and Violent Crimes by Week

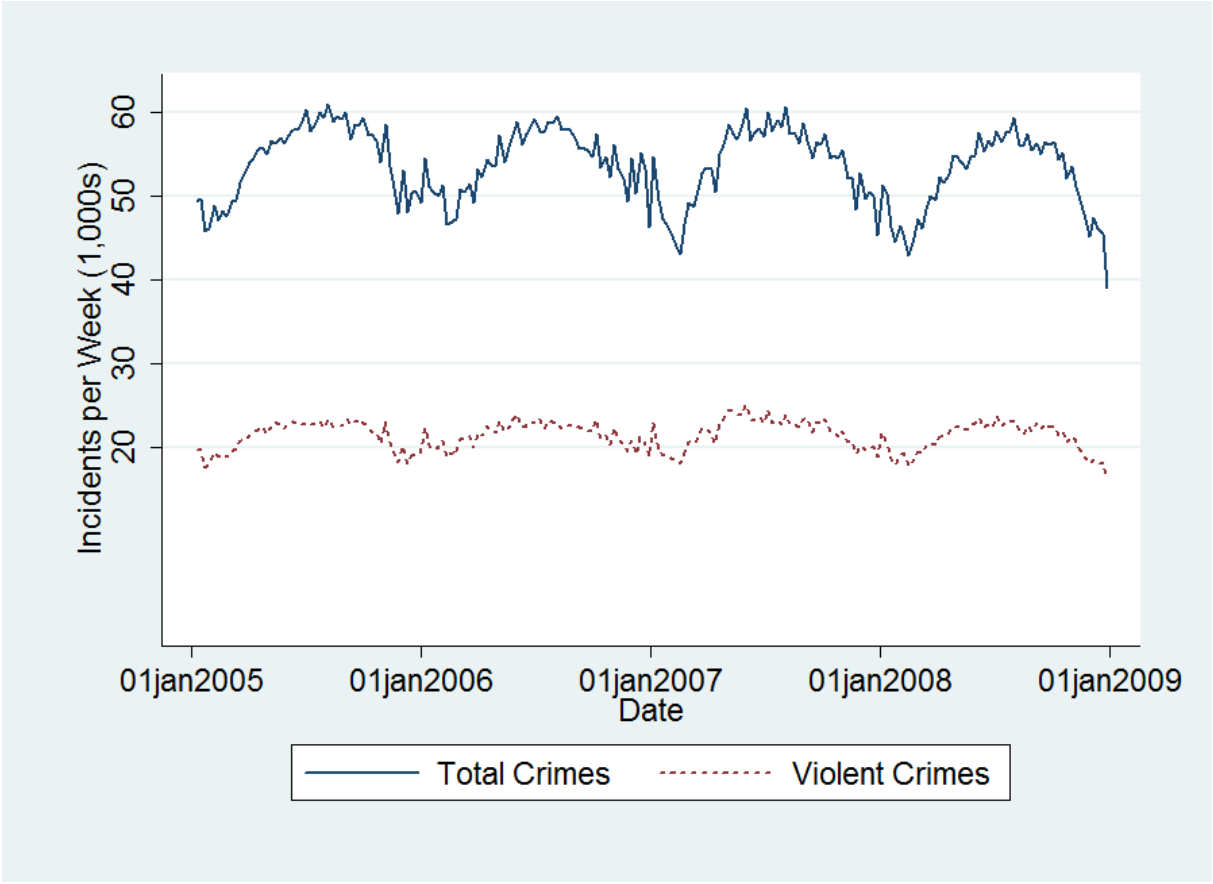

Figure 5

Intensely Violent Video Game Sales and Crimes Around the Release of Grand Theft Auto IV

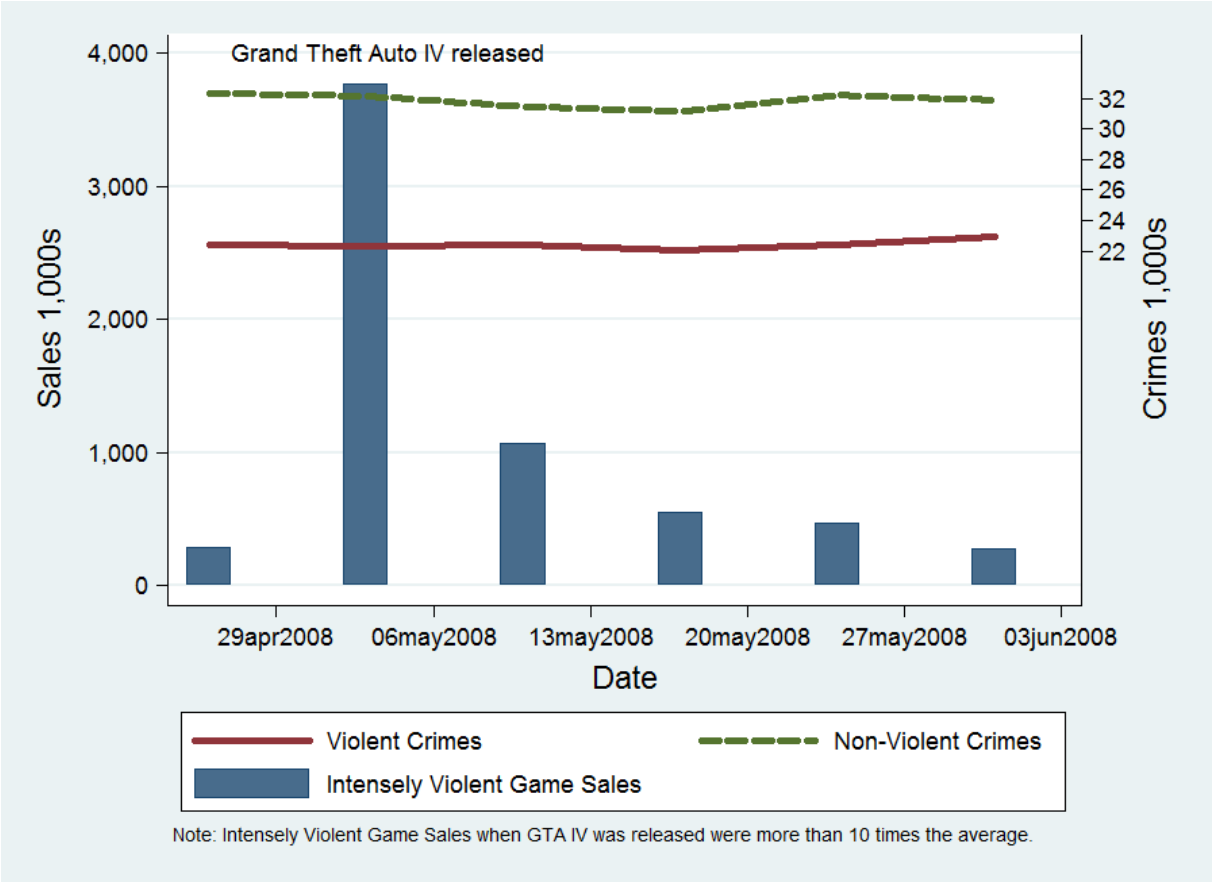

Table 1

Comparison of Unit Sales of Video Games (millions) from VGChartz and the Entertainment Software Association (ESA)

Year	VGChartz	Entertainment Software Association	Percent
2005	56.7	226.3	25.1%
2006	76.2	240.7	31.7%
2007	107.0	267.8	40.0%
2008	141.3	298.2	47.4%

VGChartz from authors' calculations and ESA from http://www.theesa.com/facts/pdfs/VideoGames21stCentury_2010.pdf.

Table 2

Summary Statistics

Variable	Mean	Std. Dev.
Intensely Violent Video Game Sales (1,000s)	256	373
Not Intensely Violent Video Game Sales (1,000s)	1,572	1,273
Average Intensely Violent GameSpot Score	8.584	0.658
Average Not Intensely Violent GameSpot Score	7.420	0.662
Average Intensely Violent Weeks on Market	18.6	13.8
Average Not Intensely Violent Weeks on Market	18.0	9.8
Violent Crimes	19,639	1,601
All Crimes	49,491	4,168
Violent Crimes in High Youth Counties	7,377	584
Violent Crimes in Low Youth Counties	12,263	1,050
All Crimes in High Youth Counties	30,586	2,714
All Crimes in Low Youth Counties	18,905	1,500
Violent Crimes on Campuses	871	338
Violent Crimes Not on Campuses	20,524	1,830
All Crimes on Campuses	1,887	630
All Crimes Not on Campuses	51,628	4,667

Descriptive statistics of the 208 observations used in later tables.

Table 3

Tests of Time Series Stationarity

Variable	Z value
Violent Crimes	-3.132*
All Crimes	-3.688**
Violent Video Game Sales	-4.430**
Non-Violent Video Game Sales	-3.475+

The null hypothesis is that there is a unit root in de-seasoned and de-trended time series data. We report the results of Augmented Dickey-Fuller tests for a unit root with four lags. Lag length determined by Schwarz's Bayesian information criterion (SBIC).

+ significant at 10%; * significant at 5%; ** significant at 1%

Table 4

Ordinary Least Squares (OLS) Results of Video Game Sales on Crime

	Violent Crimes	All Crimes
Non-Violent Video Game Sales Lagged 1 week	-0.011	-0.026
	(0.108)	(0.229)
Non-Violent Video Game Sales Lagged 2 weeks	-0.066	-0.206
	(0.109)	(0.231)
Non-Violent Video Game Sales Lagged 3 weeks	0.100	0.168
	(0.109)	(0.232)
Non-Violent Video Game Sales Lagged 4 weeks	-0.201+	-0.368
	(0.109)	(0.231)
Violent Video Game Sales Lagged 1 week	-0.117	-0.227
	(0.189)	(0.401)
Violent Video Game Sales Lagged 2 weeks	-0.242	-0.595
	(0.198)	(0.420)
Violent Video Game Sales Lagged 3 weeks	-0.290	-0.543
	(0.198)	(0.420)
Violent Video Game Sales Lagged 4 weeks	-0.239	-0.686+
	(0.189)	(0.402)
Year	68.793	-500.642**
	(84.221)	(179.011)
Week Dummies	Sign.	Sign.
R-squared	0.891	0.928

Sample includes 204 weekly observations. Specification includes 52 weekly dummy variables. Standard errors are in parentheses. ** p<0.01, * p<0.05, + p<0.1

Table 5

Summary of Main Results

Including Christmas Season

	OLS		2SLS	
	Violent Crimes	All Crimes	Violent Crimes	All Crimes
Sum Non-Violent Video Games Coefficients	-0.179	-0.432	-0.129	-0.016
	(0.166)	(0.352)	(0.435)	(0.854)
Sum Violent Video Games Coefficients	-0.888**	-2.051**	-2.351**	-3.864**
	(0.255)	(0.542)	(0.513)	(1.009)
Non-Violent Video Game Elasticity	-0.013	-0.013	-0.010	0.000
Violent Video Game Elasticity	**-0.011**	**-0.010**	**-0.028**	**-0.019**

Excluding Christmas Season

	OLS		2SLS	
	Violent Crimes	All Crimes	Violent Crimes	All Crimes
Sum Non-Violent Video Games Coefficients	-0.036	0.303	0.481	0.946
	(0.242)	(0.482)	(0.525)	(0.908)
Sum Violent Video Games Coefficients	-0.741**	-1.909**	-2.669**	-3.645**
	(0.262)	(0.532)	(0.639)	(1.106)
Non-Violent Video Game Elasticity	-0.002	0.007	0.027	0.022
Violent Video Game Elasticity	**-0.007**	**-0.008**	**-0.027**	**-0.015**

Estimates for the sum of coefficients on lagged terms. Standard errors are in parentheses. ** p<0.01, * p<0.05, + p<0.10. The implied elasticity of crime with respect to video game sales is calculated at sample means.

Table 6

First Stage Regressions of Video Game Sales lagged 1 week

on Average Video Game Characteristics

	Non-Violent Games		Violent Games	
	Coef.	Std. Err.	Coef.	Std. Err.
Violent Average Quality lagged 1 week	212.49*	(98.75)	143.66*	(59.87)
Violent Average Quality lagged 2 weeks	-82.18	(121.28)	-111.07	(73.53)
Violent Average Quality lagged 3 weeks	172.99	(120.24)	-23.96	(72.90)
Violent Average Quality lagged 4 weeks	-147.29	(93.48)	-89.33	(56.67)
Non-Violent Average Quality lagged 1 week	327.51**	(99.93)	40.09	(60.58)
Non-Violent Average Quality lagged 2 weeks	-165.86	(121.80)	-40.31	(73.84)
Non-Violent Average Quality lagged 3 weeks	-13.84	(119.69)	-3.54	(72.56)
Non-Violent Average Quality lagged 4 weeks	-44.93	(95.48)	-7.15	(57.89)
Violent Average Age lagged 1 week	0.55	(5.66)	-14.61**	(3.43)
Violent Average Age lagged 2 weeks	1.24	(6.75)	7.67+	(4.09)
Violent Average Age lagged 3 weeks	-12.80+	(6.85)	-1.72	(4.15)
Violent Average Age lagged 4 weeks	5.51	(5.61)	3.80	(3.40)
Non-Violent Average Age lagged 1 week	-30.63**	(9.07)	6.69	(5.50)
Non-Violent Average Age lagged 2 weeks	21.01*	(9.73)	2.45	(5.90)
Non-Violent Average Age lagged 3 weeks	14.16	(10.02)	2.57	(6.07)
Non-Violent Average Age lagged 4 weeks	19.20+	(9.77)	11.32+	(5.92)

Sample includes 204 weekly observations. Specification includes 52 weekly dummy variables and an annual time trend. Standard errors are in parentheses. ** p<0.01, * p<0.05, + p<0.1

Table 7

Summary Results for Under-Identification in First Stage Regressions

Variable	Shea Partial R^2	Partial R^2	F(16, 135)
Non-Violent Game Sales lagged 1 week	0.321	0.305	3.71**
Non-Violent Game Sales lagged 2 weeks	0.316	0.312	3.82**
Non-Violent Game Sales lagged 3 weeks	0.316	0.305	3.70**
Non-Violent Game Sales lagged 4 weeks	0.259	0.284	3.34**
Violent Game Sales lagged 1 week	0.180	0.274	3.18**
Violent Game Sales lagged 2 weeks	0.210	0.247	2.77**
Violent Game Sales lagged 3 weeks	0.225	0.286	3.38**
Violent Game Sales lagged 4 weeks	0.187	0.224	2.43**

This table summarizes the explanatory power of the instrument set for each of the instrumented variables. ** $p<0.01$

Table 8

Two Stage Least Squares (2SLS) Results of Video Game Sales on Crime

	Violent Crimes	All Crimes
Non-Violent Video Game Sales Lagged 1 week	-0.292	-0.478
	(0.209)	(0.410)
Non-Violent Video Game Sales Lagged 2 weeks	-0.251	-0.570
	(0.212)	(0.417)
Non-Violent Video Game Sales Lagged 3 weeks	0.394+	0.903*
	(0.213)	(0.418)
Non-Violent Video Game Sales Lagged 4 weeks	0.020	0.130
	(0.234)	(0.460)
Violent Video Game Sales Lagged 1 week	0.196	0.494
	(0.488)	(0.958)
Violent Video Game Sales Lagged 2 weeks	-0.291	-0.453
	(0.474)	(0.932)
Violent Video Game Sales Lagged 3 weeks	-0.572	-0.768
	(0.457)	(0.899)
Violent Video Game Sales Lagged 4 weeks	-1.684**	-3.137**
	(0.479)	(0.942)
Year	195.233	-492.913
	(181.398)	(356.404)
Week Dummies	Sign.	Sign.
Sargon's statistic: $\chi^2(8)$	9.661	10.488
	[0.29]	[0.232]
R-squared	0.813	0.894

Sample includes 204 weekly observations. Specification includes 52 weekly dummy variables. Standard errors are in parentheses. ** p<0.01, * p<0.05, + p<0.1

Table 9

Robustness Check of Crimes on Youth Population of County

	Violent Crimes		All Crimes	
	Low Youth	High Youth	Low Youth	High Youth
Non-Violent Video Game Sales	-0.179	-0.119	-0.186	-0.338
Lagged 1 week	(0.123)	(0.087)	(0.169)	(0.251)
Non-Violent Video Game Sales	-0.175	-0.098	-0.241	-0.420
Lagged 2 weeks	(0.125)	(0.088)	(0.171)	(0.256)
Non-Violent Video Game Sales	0.220+	0.135	0.356*	0.407
Lagged 3 weeks	(0.125)	(0.088)	(0.172)	(0.256)
Non-Violent Video Game Sales	0.057	-0.062	-0.019	0.074
Lagged 4 weeks	(0.138)	(0.097)	(0.189)	(0.282)
Violent Video Game Sales	0.192	0.020	0.226	0.300
Lagged 1 week	(0.288)	(0.202)	(0.394)	(0.588)
Violent Video Game Sales	-0.051	-0.218	-0.410	0.003
Lagged 2 weeks	(0.280)	(0.197)	(0.383)	(0.571)
Violent Video Game Sales	-0.356	-0.148	-0.275	-0.413
Lagged 3 weeks	(0.270)	(0.190)	(0.370)	(0.551)
Violent Video Game Sales	-0.891**	-0.721**	-1.452**	-1.829**
Lagged 4 weeks	(0.283)	(0.199)	(0.387)	(0.578)
2SLS Estimator. Specification includes 52 weekly dummy variables and an annual trend. Standard errors are in parentheses.				
Sum Non-Violent Video Games Coefficients	-0.077	-0.144	-0.090	-0.277
	(0.256)	(0.180)	(0.351)	(0.524)
Sum Violent Video Games Coefficients	-1.105**	-1.067**	-1.911**	-1.938**
	(0.303)	(0.213)	(0.415)	(0.619)
Estimates for the sum of coefficients on lagged terms. Standard errors are in parentheses.				
Non-Violent Video Game Elasticity	-0.010	-0.031	-0.008	-0.014
Violent Video Game Elasticity	**-0.023**	**-0.037**	**-0.026**	**-0.016**

Implied elasticity of crime with respect to video game sales. Calculated at sample means.
** p<0.01, * p<0.05, + p<0.1

Table 10

Robustness Check of Crimes on Campuses and off Campuses

	Violent Crimes		All Crimes	
	Off Campus	On Campus	Off Campus	On Campus
Non-Violent Video Game Sales	-0.260	-0.032	-0.414	-0.065
Lagged 1 week	(0.193)	(0.025)	(0.382)	(0.047)
Non-Violent Video Game Sales	-0.237	-0.014	-0.524	-0.046
Lagged 2 weeks	(0.196)	(0.026)	(0.388)	(0.048)
Non-Violent Video Game Sales	0.342+	0.052*	0.827*	0.076
Lagged 3 weeks	(0.196)	(0.026)	(0.389)	(0.048)
Non-Violent Video Game Sales	0.013	0.007	0.158	-0.029
Lagged 4 weeks	(0.216)	(0.028)	(0.428)	(0.053)
Violent Video Game Sales	0.172	0.024	0.430	0.064
Lagged 1 week	(0.450)	(0.059)	(0.892)	(0.110)
Violent Video Game Sales	-0.272	-0.019	-0.385	-0.069
Lagged 2 weeks	(0.438)	(0.057)	(0.867)	(0.107)
Violent Video Game Sales	-0.525	-0.047	-0.741	-0.028
Lagged 3 weeks	(0.422)	(0.055)	(0.837)	(0.103)
Violent Video Game Sales	-1.559**	-0.125*	-2.890**	-0.248*
Lagged 4 weeks	(0.442)	(0.058)	(0.877)	(0.108)
2SLS Estimator. Specification includes 52 weekly dummy variables and an annual trend. Standard errors are in parentheses.				
Sum Non-Violent Video Games Coefficients	-0.142	0.013	0. 048	-0.064
	(0.401)	(0.052)	(0.795)	(0.098)
Sum Violent Video Games Coefficients	-2.184**	-0.167**	-3.584**	-0.280*
	(0.474)	(0.062)	(0.939)	(0.116)
Estimates for the sum of coefficients on lagged terms. Standard errors are in parentheses.				
Non-Violent Video Game Elasticity	-0.011	0.024	0.001	-0.053
Violent Video Game Elasticity	**-0.027**	**-0.049**	**-0.018**	**-0.038**
Implied elasticity of crime with respect to video game sales. Calculated at sample means. ** p<0.01, * p<0.05, + p<0.1				

Endnotes

[*] We wish to thank Stephen Frasure for excellent research assistance. We received helpful comments from Irene Bertschek, Pierre Mohnens, the 9th ZEW ICT Conference, Paris ICT Conference 2011, UT Arlington, Munich ICT Conference 2012, Middlesex University and UNC Charlotte.

[2] In 2010, California passed a law making it a punishable offense for a distributor to sell a banned violent video to a minor. The US Supreme Court struck down this law in June, 2011.

[3] There is disagreement within the psychological literature about the interpretation of psychological laboratory studies of video game violence (Ferguson & Kilburn, 2008).

[4] http://www.vgchartz.com

[5] http://www.esrb.org

[6] http://www.gamespot.com

[7] A variant of the Becker and Murphy (1988)'s rational addiction model may approximate GAM. The key insight for GAM is that consumption of a good in one particular not only affects current utility directly, but through a capital stock accumulation mechanism, it also affects future utility indirectly.

[8] The website, How Long to Beat, http://www.howlongtobeat.com, provides user-submitted statistics on completion times. The 2011 blockbuster, The Elder Scrolls V: Skyrim, lists completion times between 100 and 330 hours. The 2008 hit, Grand Theft Auto IV, lists 12 to 162 hours, with the lower bound 12 hours recorded for a "speed trial" effort to complete the game as fast as possible.

[9] Our empirical methodology is in large part based on DellaVigna and Dahl's (2009) study of the effect of movie violence on crime.

[10] VGChartz uses a variety of sources to collect data. These include manufacturer shipments, data from tracking firms, retailer and end user polls, and "statistical trend fitting." While VGChartz reports by global region, e.g. US, Japan, Europe, Middle East, Africa and Asia, disaggregated sales within a region is not available.

[11] http://www.theesa.com – The reported numbers from ESA also include games for personal computers which amount to about 10 percent of the market each year and are intentionally not included in VGChartz.

[13] Unreported regressions comparing games that are either "intensely violent" or "violent" versus all other games generally yield much less precisely estimated parameters.

[14] Unreported results for the other lag structures are similar.

[15] Anderson (2004) notes the lack of longitudinal studies of effects of violent video games on aggression and calls for more studies aimed at investigating the long-term effects. The best evidence we have at present from laboratory studies is primarily short-run, making our study more suitable for comparison.

[16] This is based on a total of over 1.2 million violent crimes reported in the FBI's "Crime in the United States" http://www.fbi.gov/about-us/cjis/ucr/crime-in-the-u.s/2010/crime-in-the-u.s.-2010/tables/10tbl01.xls.

[17] This is based on 6.2 million annual property crimes reported in the FBI's "Crime in the United States" http://www.fbi.gov/about-us/cjis/ucr/crime-in-the-u.s/2010/crime-in-the-u.s.-2010/tables/10tbl01.xls.