

# The effect of casino proximity on lottery sales: Zip code-level evidence from Maryland\*

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**Abstract:** The continued expansion of the casino industry has caused increasing concern regarding the cannibalization of other industries (e.g., state lotteries), an issue of particular importance to policymakers since casinos and lotteries can make a significant impact on state budgets. Although previous papers have found that casinos and lotteries act as substitutes, no previous research has analyzed the impact of casino proximity on lottery sales or examined the relationship between casinos and different types of lottery games. In this paper we examine zip code-level monthly lottery sales data from Maryland between July 2009 and February 2014. Using a two-way fixed effects OLS model, we test the impact of casino proximity on lottery sales by type of game. Our findings indicate that lottery sales decline more in close proximity to casinos, with monitor and multi-state games most affected. We estimate that casinos in Maryland have led to a decrease in lottery sales of approximately \$44-50 million per year, or 2.7% of annual sales. Two additional casinos will have opened in Maryland between the end of our sample period and the end of 2016. We forecast the impact of these casinos to be an additional decline in annual lottery sales of approximately \$45 million, or another 2.6% of sales. Replication of this analysis in other jurisdictions could help to guide policymakers toward more efficient gambling policy. (223 words)

**Keywords:** Lottery, casinos, tax revenues, competition

**JEL Codes:** H270, H4, L83

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## 1. Introduction

Legal gambling has been an increasingly important policy issue for state governments since New Hampshire introduced a lottery in 1964. Other states followed suit, and now only a few states do not have lotteries. Beginning in 1989 legal casinos began spreading outside Nevada and Atlantic City, NJ, and now casinos operate in at least 39 states.<sup>1</sup> U.S. lottery sales in fiscal year 2012 were about \$69 billion, and U.S. casinos bring in more than \$60 billion in revenue per year.<sup>2</sup> Gambling taxes can be significant sources of state government revenue. The effective lottery “tax” averages around 40%, after accounting for administrative expenses (Perez and Humphreys 2013, 927). Commercial casino gross revenues are taxed at rates ranging from about 6% in Nevada up to nearly 70% in states such as Maryland and Rhode Island (American Gaming Association 2013). Since the lottery tax and taxes on casino revenues are relatively high, legal gambling has become an important component of many states’ budgets.

As casino gambling continues to expand, especially in the Northeast, there is increasing concern that casino revenues may come at the expense of lottery sales (i.e., revenue “cannibalization”), thus raising questions about the net tax impacts of casino legalization. Although there have been analyses of the inter-industry relationships between casinos and lotteries, many of these studies were published at a time when casinos were relatively isolated.

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<sup>1</sup> For an analysis of the factors affecting lottery adoptions, see Alm, McKee, and Skidmore (1993) or Jackson, Saurman, and Shughart (1994); for a similar analysis of commercial casinos, see Calcagno, Walker, and Jackson (2010).

<sup>2</sup> For detailed lottery data, see <http://naspl.org/>. More information on commercial casinos can be found in American Gaming Association (2013). Casino revenue data are from Walker (2013).

Isolated casinos could attract a large number of visitors from out-of-state, which may have hidden or minimized any negative impacts casinos had on lotteries. Nevertheless, early evidence still suggested that lotteries and casinos were substitutes to a degree. No published study to date has addressed the degree to which proximity to casinos impacts lottery sales, nor has any examined the relationship between casinos and specific types of lottery games. These issues are of importance since they can be critical to understanding the likely impact of new casinos on existing lotteries. An understanding of these relationships would be useful to policymakers and voters grappling with the legalization or expansion of casino gambling so as to maximize its net benefits.

In this study we use zip code-level monthly lottery sales data to analyze the impact of casino proximity on the sales of different types of lottery products. Our analysis focuses on Maryland, where casinos began operating in September 2010. Our findings are that casinos have had a statistically significant negative impact on Maryland lottery sales, with an estimated decline in annual lottery sales of \$44-50 million (or 2.7%) due to casinos, and that the casinos' cannibalization of lottery revenues is greater in close proximity to casinos. Monitor and multi-state lotto games see the largest negative impact on sales from the presence of casinos. A new casino has opened in Maryland since the end of our sample period and another will open before the end of 2016, and our model predicts that these two casinos together will have a similar impact to the existing four casinos – about a 2.6% negative impact on annual lottery sales. This analysis can serve as a model for similar studies in other jurisdictions with expanding casino industries. This study should also further policymakers' understanding of how legalizing new forms of gambling can affect existing gambling industries, and provide useful information to help in the formation of optimal policy toward legalized gambling. The paper consists of five

sections. The next section provides background information and a literature review. Section 3 presents the data. The model, basic results, and additional analyses are presented in Section 4. In Section 5 we conclude with a final discussion of the results and their implications.

## **2. Background and literature review**

Since all but a handful of states operate lotteries, there has been increasing concern with the continued expansion of casinos across the United States and the potential of casinos to compete with lotteries. If casinos attract revenues at the expense of lottery sales (i.e., if casinos cannibalize lotteries), then the actual net impact of casino tax revenue could fall well short of policymakers' expectations or casino industry promises. There have been a number of studies in the literature which examine the inter-industry relationships for gambling. First we provide some background information on casinos and the lottery in Maryland – the focus of our empirical analysis. We then discuss the literature, focusing on papers that examine the relationship between casinos and lotteries.

### *Background on Maryland*

The Maryland Lottery began in 1973, and by the mid-1990s, annual sales surpassed \$1 billion per year. In 2004, Maryland's net revenue from the lottery was \$466.2 million, which represented about 2% of the state's total revenues (net of federal transfers) that year (Walker and Jackson 2011, 102). Nominal sales growth, however, has been modest over the past two decades. Figure 1 illustrates nominal annual lottery sales in Maryland and some nearby states. Lottery sales in Maryland appear to be flat since fiscal year 2008, with a slight decline beginning in FY 2013. While one might expect the 2007-09 recession to have had a negative impact on state

lotteries, a comparison with other nearby states raises doubt that the recession alone explains Maryland's recent lottery performance. Given that the casino expansion in Maryland coincides closely with the leveling-off of lottery sales, Maryland provides a suitable case-study for the relationship between casinos and lottery sales.<sup>3</sup> The explanation of the decline in lottery sales would presumably be of great interest to policymakers in Maryland and in other states with expanding casino industries and shrinking or stagnant lotteries.

**[Figure 1 here]**

Maryland legalized casinos in 2008, and the Hollywood Casino was the first to open in September of 2010 in Perryville. Four other casinos have opened since then: Ocean Downs (January 2011), Maryland Live (June 2012), Rocky Gap (May 2013), and the Horseshoe in Baltimore (August 2014 – beyond the sample period that we examined in this study). A sixth casino (MGM) is slated to open in summer 2016. Figure 2 is a map of Maryland that shows the locations of all six casinos in the state, as well as nearby casinos outside Maryland.

**[Figure 2 here]**

### *Literature review*

Lotteries received much attention in the literature during the 1980s and early '90s, particularly focused on factors explaining their adoption, their regressive nature, and cross-

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<sup>3</sup> It is interesting to note that Pennsylvania's first casino opened in November, 2006. Lottery sales were flat there from 2006 to 2010, perhaps due in part to the recession. Since 2010, the Pennsylvania Lottery's sales have been increasing.

border purchases.<sup>4</sup> More recently, as casinos have spread across the United States, researchers have analyzed the inter-industry relationships among different forms of gambling. The most recent and comprehensive analysis of the general relationships among gambling industries is by Walker and Jackson (2008). They examined state-level gambling industry data from 1985 to 2000 for commercial casinos, lotteries, greyhound racing, and horse racing in all states. Their sample period included much of the early casino expansion in the United States. Their key result relevant to our study is that casinos have a negative impact on the lottery in states that have both forms of gambling. Unfortunately, the Walker and Jackson analysis does not provide information on the degree to which increased casino revenues tend to decrease lottery sales.

Other evidence from the literature also supports the conclusion that there is some degree of cannibalization between casinos and lotteries. For example, Elliott and Navin (2002) developed a panel-data model estimating state-level gross lottery revenues for all lottery states from 1989 to 1995. Their findings indicated that casinos and pari-mutuel betting both caused reductions in state lottery revenues. They found that “each additional dollar of revenue from riverboat gambling reduces gross state lottery revenue by \$1.38.” They estimated that a \$1.00 gain in casino taxes caused a loss of \$0.83 in lottery taxes, so that the introduction of casinos only modestly increased net tax revenues from gambling.

Fink and Rork (2003) extended the work by Elliott and Navin by taking into account the fact that when states legalize casinos they are making a choice: states may introduce casinos because of declining lottery revenues. Thus, there is a potential self-selection bias which might help explain the negative relationship between casinos and lotteries. Fink and Rork’s analysis also indicated that casino tax revenues cannibalize lottery revenues. Specifically, they found that

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<sup>4</sup> For a comprehensive discussion of lotteries see Clotfelter and Cook (1991).

a \$1 increase in casino tax revenues results in a 56¢ decrease in lottery tax revenues, a substitution effect slightly smaller than that estimated by Elliott and Navin.

Siegel and Anders (2001) tested the impact of Arizona tribal casinos on the state's lottery sales, using monthly data from 1993 to 1998. Their findings indicated the number of slot machines had a significantly negative effect on lottery sales, but horse and dog racing had no effect on the lottery. Specifically, their results indicated that after seasonal adjustments, a 10% increase in slot machines was associated with a 2.8% decline in [overall] lottery revenues and a 3.7% decrease in Lotto revenues (p. 144).

In addition to the academic papers discussed above, there have been several consulting and government reports that have addressed the relationships between casinos and lotteries. These studies can provide interesting anecdotal evidence. For example, Spectrum Gaming Group (2008) analyzed the expected impact of casinos in Massachusetts on the state's lottery. As a part of their analysis, they calculated growth rates in population and lottery revenues prior to and after the introduction of casinos in all casino states. They found that lotteries' sales growth rates were 5.8% on average prior to casinos and only 1.2% after their introduction.

By Pennsylvania law, the state's Legislative Budget and Finance Committee is required to release annual reports that examine the impact of slot machines (and casino gambling generally) on the Pennsylvania State Lottery. This report typically includes recent data on lottery ticket sales and casino revenues, showing the trends in each. Their report indicates that the growth rate of lottery sales in casino hosting counties is lower than in non-casino counties. In fact, the growth rate in casino counties is typically less than half that in the non-casino counties (Pennsylvania Legislative Budget and Finance Committee 2013, 4). These data suggest that casinos dampen lottery ticket sales, at least in areas close to casinos.

Recent evidence of a negative impact of casinos on lotteries has surfaced in other states as well. For example, casinos began operating in Ohio in 2012. A report by Bell (2013) indicates that Ohio Lottery's scratch-ticket sales declined by 4% in the first year of casino operations, and other games also declined.

Both empirical and anecdotal evidence suggests that casinos harm lotteries, at least at the state level. There is, however, no rigorous empirical evidence as to how individual lottery game sales react to casinos, or regarding the impacts of proximity to casinos. Such information can be useful for informing policymakers on the likely net effect of casino legalization and optimal casino location, once the impact on existing lotteries is taken into consideration.

### **3. Data**

The Maryland State Lottery and Gaming Control Agency, through its vendor Scientific Games, provided us detailed lottery sales data from July 2009 through February 2014. There were 17 different types of traditional lottery products available during our sample period. We have monthly lottery sales data by game type for each retailer in the state during that period. We thus have 238,208 retailer-level months of data for the 17 types of games, for a total of about 4 million data points.

The 17 different lottery games can be generally classified into five different types of games. In Table 1 we describe the different lottery products offered in Maryland during our sample period.

**[Table 1 here]**



Figure 3 illustrates Maryland's total monthly lottery sales. Monthly lottery sales are highly variable, ranging from \$120-183 million during our sample period, with an average of around \$145 million. In Figure 4 we show lottery sales by the game categories as listed in Table 1. *Instant*, *monitor*, and *pick* games average around \$40 million each in monthly sales; *multi-state* ("large" lotto) game sales are typically around \$15 million per month; and *other* games account for \$4.5 million of monthly sales.

**[Figure 3 here]**

**[Figure 4 here]**

Examining Figures 3 and 4, it appears that a downward monthly trend began in early 2012 (Figure 3), caused primarily by declines in instant and monitor games (Figure 4).<sup>5</sup>

There is good reason to believe that the different types of lottery games might have different relationships with casinos. For example, the Maryland Lottery offers a Keno game, which is almost identical to the same game that is offered at most casinos, including those in Maryland. On the other hand, no casino game offers the almost unimaginable jackpot size that one can win from Powerball and MegaMillions games. We might therefore expect games like Keno to be harmed to a greater extent than the multi-state games, simply because casinos offer a closer substitute to Keno than to the multi-state games. We therefore analyze the lottery sales data aggregated to the five game types shown in Table 3. We believe this is the first paper to analyze lottery game sales by category.

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<sup>5</sup> A review of individual graphs by lottery type bears this out. For the sake of brevity we present all sales data in Figure 4, rather than showing a separate graph for each type.

Our primary interest in this paper is to analyze the impact of casino proximity on lottery sales. We have lottery sales data at the retailer level (4,000+ of them) and, although we could attempt to model sales at any particular retailer as a function of distance to casinos, such a micro-level analysis would be extremely tedious to perform and interpret. It would also be unlikely to provide advantages over a simpler, more aggregated approach. Alternatively, we could attempt a county-level analysis. However, the counties in Maryland are few and relatively large. The fact that the large Maryland Live casino is located very near the corner of three large, relatively populous counties raises doubt that a county-level model would be useful. Given our data, we view the best scale of analysis to be at the zip code level. We therefore aggregate the lottery sales data by type of game (as listed in Table 1) and zip code. We use zip code tract areas (ZipCTAs, which represent “populated” zip codes) provided by Easy Analytic Software Inc. There are 461 such zip codes in Maryland, but only 387 such zip code areas have lottery retailers, and therefore sales data. We assume that the centroid of each zip code represents the location of the typical lottery retailer for that zip code in measuring the distance to casinos.

Next we calculated the distance from each zip code to each casino in Maryland and those in states surrounding Maryland. Distance was calculated both in miles and in typical travel time (minutes).<sup>6</sup> Because we believe that travel time is likely the most operative factor in consumers’ behavior in choosing a casino, we have used that variable as the “distance” input for our analysis. The distance variable takes a new value if a new casino is closer to the zip than any other casino.<sup>7</sup> Therefore, the distance variable can only remain constant or decrease as time passes. As

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<sup>6</sup> This was done using Microsoft MapPoint software, with occasional manual checks via MapQuest and Google Maps.

<sup>7</sup> Some casinos opened in nearby states during the period we analyzed. These include the Greenbrier in White Sulphur Springs, WV, the Valley Forge in King of Prussia, PA, and the Nemaquin Resort in Farmington, PA. The first two were never the closest casino to any zip code in Maryland. The Nemaquin is several minutes travel time closer to some Maryland zip codes, but opened less than two months after the Rocky Gap. The most relevant out-of-

an example, zip code 21012 is located at and around Arnold, in Anne Arundel County. From July 2009 through August 2010 (periods 1-14), the closest casino was outside Maryland, about 70 minutes away, at the Harrington Raceway in Harrington, DE. Thus, the variable takes a value of 70 for periods 1-14. When the Hollywood Casino opened in Perryville in late September 2010 (period 15), it became the closest casino to zip code 21012, with a typical travel time of 64.5 minutes.<sup>8</sup> When the Ocean Downs casino opened in Berlin in January 2011, it was not as close to 21012 as the Hollywood Casino was, so the variable remains unchanged at the value of 64.5.

#### **4. Model and analysis**

##### *Model*

Maryland is surrounded by states that also sell lottery tickets and have casinos. Virginia is the only neighboring state that does not currently offer commercial casinos. As it is likely that most of Maryland's lottery ticket sales are attributable to its own residents, a model that considers mainly factors within Maryland seems reasonable for explaining changes in lottery sales as casinos have spread. We therefore posit a simple OLS gravity model with two-way fixed effects to analyze the impact of casino location on lottery sales. To the extent that casinos and lotteries have a substitute relationship with each other, we would expect that this effect would be stronger in closer proximity to casinos. A straightforward gravity variable in which the variable declines at a linear rate with travel time is:

$$Gravity = 1 / travel\ time \tag{1}$$

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state casinos are in Charles Town, WV, and three in Delaware, and these were all opened long before and remained open throughout our sample period.

<sup>8</sup> In calculating the travel time to the closest casino for the Hollywood's first (partial) month, we used a weighted average of the old time and new time. For zip 21012 in period 15, this value is 69.3, which reflects that the Hollywood was open few days in that month. For period 16 (October 2010), the casino was open the full month, so the travel time takes a value of 64.5 in that period and after, until a closer casino opens.

Then when the travel time to the nearest casino decreases, the *Gravity* variable increases in value.<sup>9</sup>

Rather than using gross zip code-level lottery sales for each period as our dependent variable, we use “change in sales” ( $\Delta Sales$ ) over the same month a year ago. This way, factors that impact sales in both periods net out, and will help to better isolate the impact of the introduction of a new casino nearby. In addition, using the change in sales will help to control for any seasonality in the data. Therefore, our model explains the dollar change in sales for zip code  $i$  in period  $t$ , calculated as:

$$\Delta Sales_{i,t} = Sales_{i,t} - Sales_{(i,t-12)}. \quad (2)$$

Our primary explanatory variable is the change in the gravity variable from the same month the prior year:

$$\Delta Gravity_{i,t} = Gravity_{i,t} - Gravity_{(i,t-12)}, \quad (3)$$

where  $Gravity = 1 / travel\ time$ . Thus, a particular month’s change in sales over the same month the last year is explained in the model by the change in the gravity variable over the same month in the prior year plus an error term.

Since we are attempting to explain change in lottery sales, not the level of sales, a two-way fixed effects model is appropriate for controlling for other potentially relevant effects across zip codes and through time. For our basic model we have:

$$\Delta Sales_{i,t} = Constant + \Delta Gravity_{i,t} + \varepsilon_{i,t}, \quad (4)$$

where the constant term represents the sum of the zip code and period (month) fixed effects coefficients, and  $\varepsilon$  is an error term. We run the model for each category of lottery game. The results and subsequent analysis are presented below.

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<sup>9</sup> We also tested a model in which  $Gravity = 1 / travel\ time^2$ . However, the linear model appears to fit the data better.

## *Results*

In Table 2 we present the results from the basic model. The positive constant term in each model shows the average change in sales over the same month last year, for all zip codes and all months in the sample. The positive constant terms suggest that all games would be expected to see increased sales over the sample period. However, the negative sign on the  $\Delta Gravity$  variables indicate that all game types, except “other,” see a decline in  $\Delta Sales$  as casinos get closer. The magnitudes of the coefficients are not immediately obvious because they are in dollar terms, so they do not provide context to determine whether the impact is economically important. Additionally, a clear interpretation of the coefficients is complicated because we are dealing with a panel of zip codes of very diverse sizes and distances to casinos.

**[Table 2 here]**

To help with interpretation, we frame the results in the context of a “representative” (or average) zip code in Maryland and consider the impact of a new casino opening within certain proximities. At the beginning of our sample period (July 2009), the average distance to the closest casino among all zip codes was about 75 minutes. Using the coefficient estimates in Table 2 and the average lottery sales across Maryland zip codes, we develop specific estimates of the effects of a new casino opening closer to the representative zip, relative to the original 75 minute distance to the average zip code. The estimated impact is calculated by multiplying the  $\Delta Gravity$  coefficients from the regression (in Table 2) by the  $\Delta Gravity$  value when a new casino opens, then adding the constant term. For example, to calculate the effect on monitor game sales of a new casino opening 15 minutes away (i.e., 30 minutes closer than the current closest casino),

we take  $\$40.09 + (-374069.5 \times 0.053334)$ .<sup>10</sup> Thus, the estimated effect on the change in monthly monitor game sales from the new casino opening is  $-\$19,950.62$ . The difference from the baseline case, when the closest casino was 75 minutes away ( $\$40.09$  change in monthly sales) is  $-\$19,990.71$ .<sup>11</sup> The average monitor game sales in the representative zip code is  $\$109,992$ , so a change in sales of  $-\$19,991$  represents a monthly decline (over the same month the prior year) in monitor game sales of  $-18.2\%$ .

The same type of calculation was made for all the game categories assuming the hypothetical new casino opens 60, 30, and 15 minutes away. In Figure 5 we illustrate the results, which are shown relative to the benchmark in which the nearest casino is 75 minutes away. Results are shown in dollar and percentage terms (panels A and B). Since these estimated impacts occur each month, the changes can also be interpreted as the overall average impact of the new casinos opening on the average zip code over the first twelve months following such openings.

**[Figure 5 here]**

These estimates suggest that monitor games, in particular, have seen the most serious negative impact from the introduction of casinos, followed by multi-state and instant games. Across all types of lottery games, such impacts increase as the travel time to the nearest casino declines. Oddly, however, “other” games see an increase in revenues the closer the proximity to the nearest casino. We suspect this may be an artifact of their relatively recent introduction

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<sup>10</sup> The last number represents the change in gravity:  $1/75 = 0.013333$ ;  $1/15 = 0.066667$ ; the change is  $0.053334$ .

<sup>11</sup> This is calculated as  $\$40.09 - (-\$19,950.62)$ .

and/or minor (and therefore likely irregular) positions in the constellation of traditional lottery games in Maryland.<sup>12</sup>

### *Casinos' marginal impacts*

The above analysis represents a simulated new casino opening and the estimated impacts on the lottery in the hypothetical average zip code. Next we re-estimate the regression to isolate the marginal impact of each Maryland casino on each type of lottery game. We again estimate a model of  $\Delta Sales$ , but now with the  $\Delta Gravity$  variable and a marginal effects variable for each casino. The marginal effects variables are casino dummy variables interacted with the  $\Delta Gravity$  variable. The casino dummy variable takes a value of 1 during the first twelve months of casino operation. (If the casino opening was for a partial month, that month is also coded with a 1.) Thus, the casino opening dummy will be a 1 for the months during which the casino opening *could* impact the  $\Delta Gravity$  variable for a particular zip code. When this variable is interacted with the  $\Delta Gravity$  variable, the resulting variable isolates the change in gravity in any particular month to the casino responsible for the change. Therefore, the value of the marginal effects variable takes a value of the  $\Delta Gravity$  only if the opening of the new casino impacted a particular zip code's distance to the closest casino; it takes a value of 0 otherwise. Our model to test these marginal effects is:

$$\begin{aligned} \Delta Sales_{i,t} = & \text{Constant} + \Delta Gravity + (\text{Hollywood dummy} * \Delta Gravity) \\ & + (\text{Ocean Downs dummy} * \Delta Gravity) \\ & + (\text{Maryland Live dummy} * \Delta Gravity) \\ & + (\text{Rocky Gap dummy} * \Delta Gravity) + \varepsilon_{i,t} \end{aligned} \tag{5}$$

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<sup>12</sup> The "other" category of games comprises only 3.1% of average zip code's total lottery sales.

The results of this model are presented in Table 3.

**[Table 3 here]**

The impact of each casino on each type of lottery game is determined by the coefficients on  $\Delta Gravity$  and the marginal coefficient for the particular casino. As shown in the table, there are both positive and negative coefficients, with the majority being statistically significant. The interpretation of the coefficients is again somewhat complicated by the fact that we are using panel data. We therefore provide monetary estimates of the marginal impacts from the individual casinos.

#### *Estimated monetary impacts*

We provide two different estimates for the monetary impacts of Maryland casinos on lottery sales. We frame the estimated impacts based on the last full year of lottery sales for which we have data (from March 2013 to February 2014). The first estimate simply looks at the  $\Delta Gravity$  from the first month to the last month in our sample period. This value is multiplied by the coefficient estimate for  $\Delta Gravity$  from Table 2, which yields the change in monthly lottery sales due to the changes in gravity occurring as Maryland casinos opened across the state. Table 4 shows the annual estimated effects for all casinos as an aggregate. The overall impact is estimated to be -\$44.1 million per year, or 2.53% of recent annual sales, as shown in the right-most column in the table. This can be interpreted to mean that Maryland lottery sales would have been \$44 million greater each year in the absence of the four existing casinos.



**[Table 4 here]**

Also as shown in Table 4, a 95% confidence interval for the estimated impact on Maryland lottery sales lies between -\$31.7 and -\$56.5 million per year.

Next we estimate the impact of each existing Maryland casino on lottery sales by type of lottery game. The marginal casino impacts are calculated by adding the estimated  $\Delta Gravity$  effect plus the marginal impact of each casino, as shown in Table 3. The results of these calculations are shown in Table 5. We briefly discuss the results from each casino.

**[Table 5 here]**

The Hollywood Casino is estimated to have a slightly positive impact on instant lottery sales in the state (0.54%), but a negative impact on all other game types. The overall estimated effect of the Hollywood Casino is a loss in lottery sales of roughly \$2.98 million per year, or 0.17% of total lottery sales in the state. The results for Ocean Downs are modestly larger, negatively affecting each type of lottery game except “other” games. The overall impact is a loss in lottery sales of \$4.55 million, or 0.26% of total state lottery sales. The Maryland Live casino is shown to have had the largest impact on lottery sales, causing a total estimated lottery sales decline of about \$44 million (-2.54% of state lottery sales). The games most negatively impacted are monitor, multi-state, and instant games. Lastly, Rocky Gap is estimated to have modestly *positive* impacts on lottery sales, to a tune of 0.10% of annual sales, roughly \$1.7 million per year. This might be due to the unique location of Rocky Gap in a very narrow part of the state, its

attraction of visitors from other states, and perhaps the casino's positive effects on employment in the local area.

When we sum the individual casinos' effects from this marginal analysis, the casinos are estimated to have reduced total lottery sales by about 2.88%, or \$50 million – \$44 million of which is attributable to Maryland Live. This -\$50 million estimated effect is close to the estimated -\$44 million impact from the aggregate analysis presented above in Table 4.

#### *Forecasts for new casinos*

The Horseshoe Casino opened in Baltimore in August 2014, and the MGM National Harbor is expected to open in summer 2016. We next use our estimated casino impacts to forecast the likely impacts of these two new casinos on the Maryland lottery. First we recalculate the change in travel time to the closest casino for each zip code in Maryland assuming the new casinos are open. These data feed into the  $\Delta Gravity$  variable as discussed before. We then estimate the impact of the new casinos by multiplying the new  $\Delta Gravity$  by the coefficients from the aggregate model in Table 2. The results of this calculation indicate that the overall forecasted impact of the Baltimore casino is -0.88% of lottery sales, or -\$15.4 million per year. The forecasted impact of the National Harbor casino (MGM) is -0.62%, or -\$10.7 million per year. In total, the two casinos are projected to negatively impact the lottery by \$26.1 million per year, or -1.5%.

Given that the new casinos will be located in very populous areas of Maryland, we might expect that their impacts on lottery sales would be greater than the “average” effect of the existing Maryland casinos as a group calculated above. We therefore re-estimated the dollar impacts of the new casinos assuming that their impacts would be similar to the marginal effects

of the Maryland Live casino – the casino that has had the largest negative impact on lottery sales thus far (and is, probably not coincidentally, located in an area that is nearly as densely populated as the two new casinos). These results are presented in Table 6.

**[Table 6 here]**

Under this scenario, the Baltimore casino is projected to reduce total lottery sales by \$26.7 million (-1.53%), and the National Harbor casino by \$18.7 million (-1.0%) per year. The total projected impact from both new casinos is a decline in lottery sales of -\$45.4 million, a decline of 2.61% per year. When we compare these figures to the estimated impacts from the existing four casinos in Maryland (shown in Table 5), the results indicate that the two new casinos are expected to cause lottery sales to fall to a similar degree as the existing four casinos already have. The Maryland Lottery should therefore expect sales to continue to drop as the availability of casino gambling continues to expand within the state.

## **5. Discussion and conclusion**

The casino industry has clearly had a negative impact on lottery sales in Maryland. Our results confirm similar results from earlier studies for other jurisdictions. However, this study refines and extends the literature by estimating casino impacts by lottery game type. These relationships may, of course, be different in other lottery jurisdictions, depending on the regional economy, consumers' preferences, casino locations, and other factors. This study can serve as a foundation for similar studies in other jurisdictions.

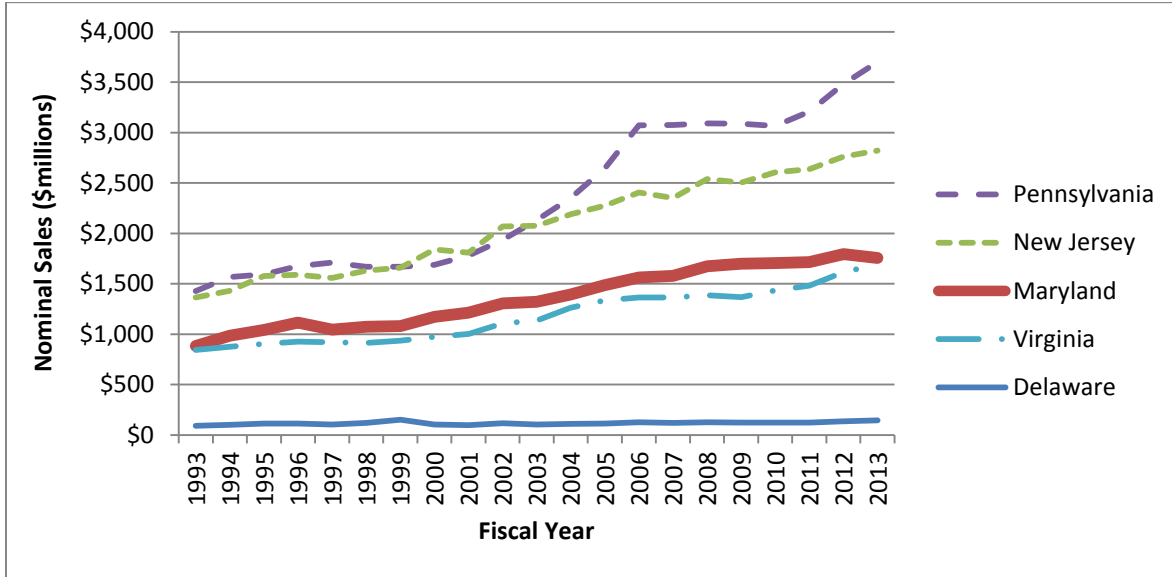
One obvious concern for policymakers should be the net impact on state tax revenues from the introduction or expansion of casinos. One recent study found that the introduction of casinos actually leads to a modest decline in state tax revenues (Walker and Jackson 2011). There is little doubt, however, that politicians see the potential tax revenues as a key benefit of casinos. Our results indicate that the tax benefits of casinos are unlikely to be as high as the gross taxes received. Indeed, once the sixth casino opens in Maryland, we anticipate that lottery sales will be almost \$100 million (5.5%) less than they otherwise would have been in the absence of all casinos. Interesting extensions to this paper would include estimating the net tax effect of introducing casinos considering their impacts upon existing lottery sales and the government receipts derived therefrom, as well as applying the model in other jurisdictions.

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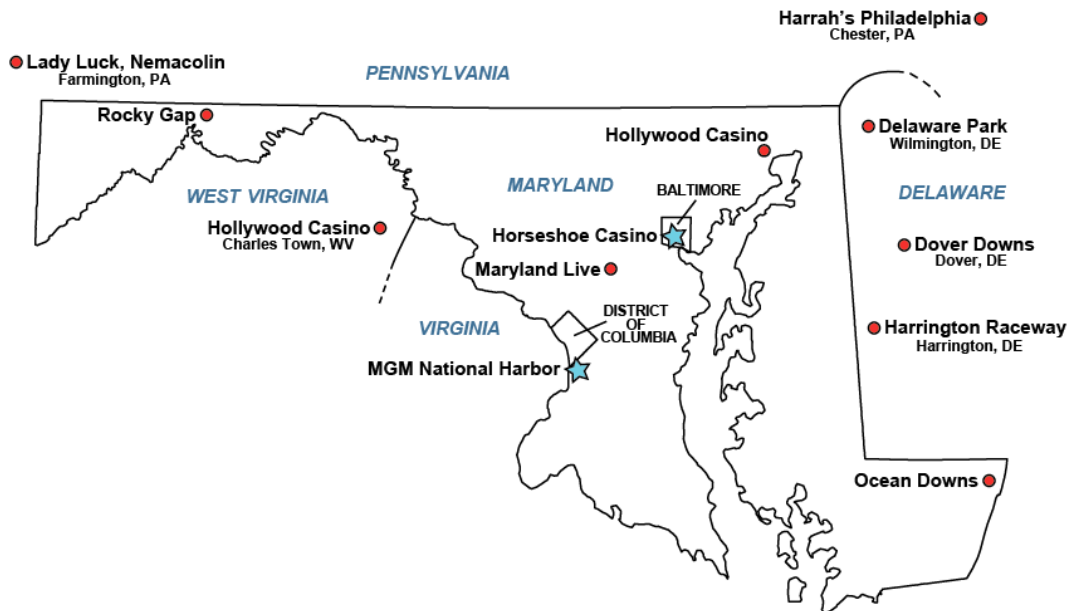
## FIGURES

**Figure 1.** Annual lottery sales (excluding VLTs) in Maryland and states nearby, FY 1993-2013

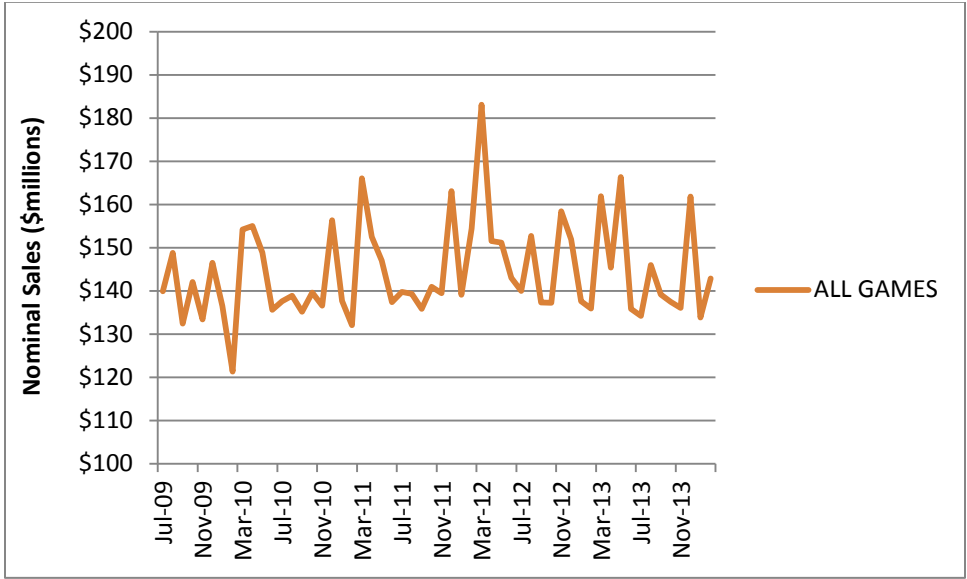


Data source: LaFleur's 2009 World Lottery Almanac, LaFleur's Magazine, and state lottery annual reports.

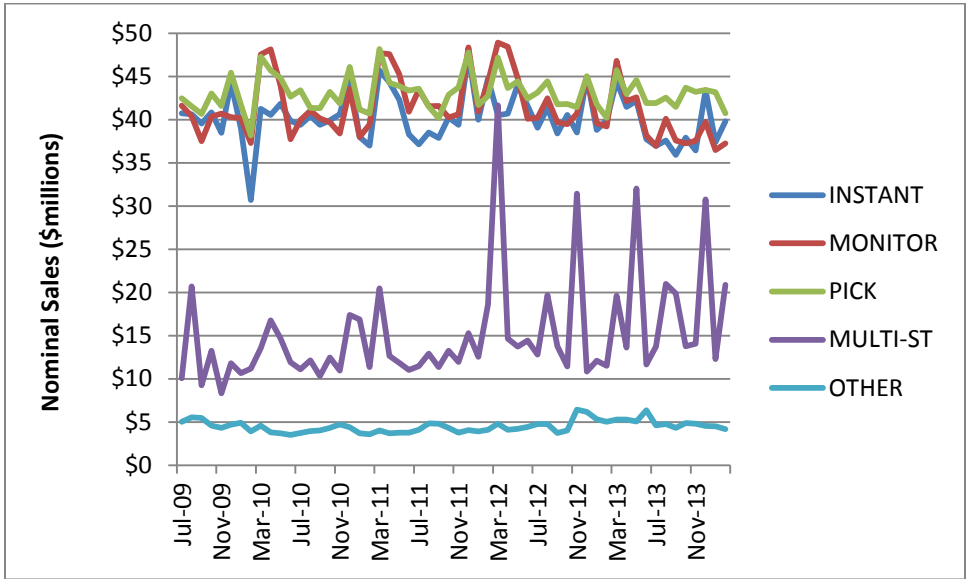
**Figure 2.** Map of casino locations in Maryland and nearby



**Figure 3.** Maryland Lottery total sales per month

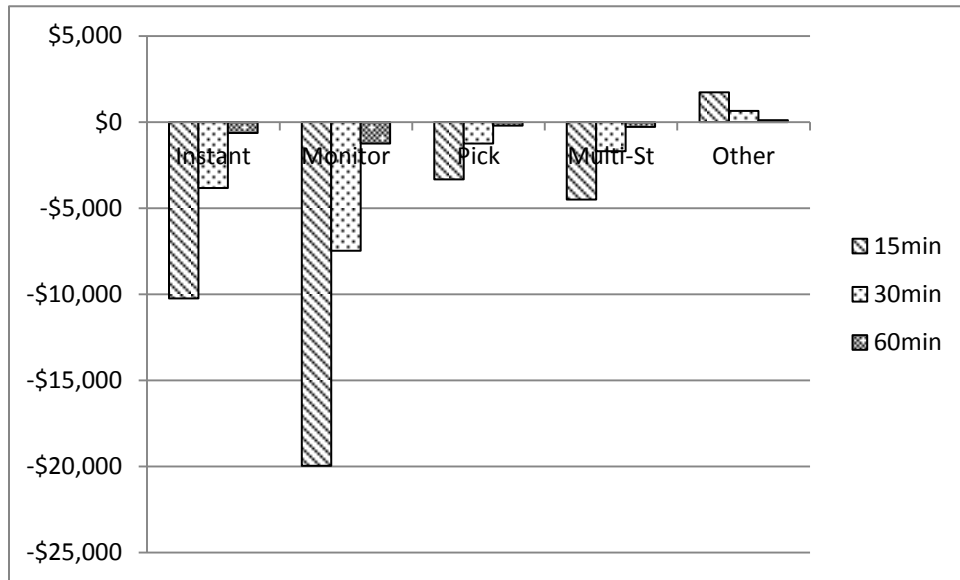


**Figure 4.** Monthly lottery sales, by game category

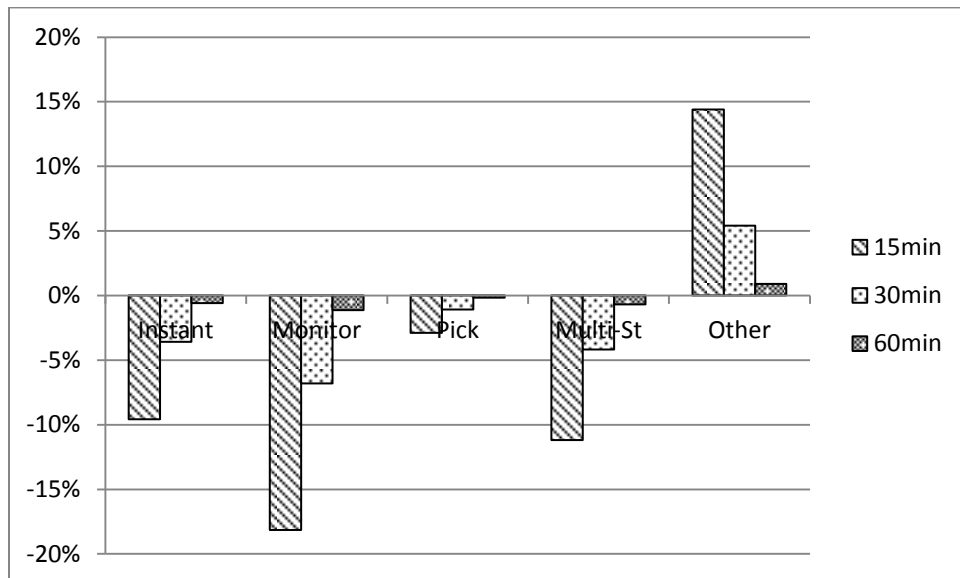


**Figure 5.** Estimated impact of a new casino opening on change in monthly sales in the representative zip code relative to the closest casino being 75 minutes away

**(A) \$ impacts**



**(B) % impacts**





## TABLES

**Table 1.** Maryland lottery game groups

<b>Game Category</b>	<b>Description</b>	<b>Game Names</b>
"Instant" tickets	Instant tickets (activations)	(various; scratch-off tickets)
"Monitor"	Games played on video monitors; many times per day, with associated bonuses	Keno, Keno Bonus, Keno Super Bonus, Racetrax, Racetrax Bonus
"Pick"	"Daily numbers" games	Pick 3 Eve, Pick 4 Eve, Pick 3 Mid, Pick 4 Mid
"Multi-State"	"Large" lotto games with associated bonus games	MegaMillions, MegaPlier, Powerball, PowerPlay
"Other"	Miscellaneous games	Bonus Match-5, 5-Card Draw, Multi-Match

<sup>a</sup> We have used the Lottery's data regarding instant-ticket-pack "activations" as our measure of the sales of such games, as does the Lottery. These slightly precede actual sales by retail agents to the consumer, but we believe they are the best available measure of such sales for our analyses.

**Table 2.** Basic regression results  
(Dependent variable: Change in Sales over same month 1 year ago)

	<b>Instant</b>	<b>Monitor</b>	<b>Pick</b>	<b>Multi-State</b>	<b>Other</b>
Constant <sup>a</sup> ( <i>p</i> -value) <sup>b</sup>	321.1293 (0.0451)	40.08864 (0.8911)	229.3958 (0.0740)	4638.434 (0.0000)	151.9791 (0.0000)
$\Delta$ Gravity ( <i>p</i> -value)	-192057.6 (0.0000)	-374069.5 (0.0000)	-62338.24 (0.0000)	-84463.49 (0.0011)	32246.77 (0.0000)
<i>n</i>	16,403	16,403	16,403	16,403	16,403
<i>R</i> <sup>2</sup>	0.256667	0.149506	0.261548	0.435712	0.331153

<sup>a</sup> The constant coefficients reported are the average of the fixed effects coefficients in the regression.

**Table 3.** Individual casino effects regression results.  
(Dependent variables: Change in Sales over same month 1 year ago)

	<b>Instant</b>	<b>Monitor</b>	<b>Pick</b>	<b>Multi-State</b>	<b>Other</b>
Constant <sup>a</sup>	461.3882 (0.0041) <sup>b</sup>	126.4801 (0.6672)	243.9563 (0.0587)	4694.665 (0.0000)	113.0446 (0.0012)
Δ Gravity	106141.6 (0.0912)	-169793.8 (0.1402)	-98848.99 (0.0503)	-323071.3 (0.0002)	-1340.454 (0.9215)
Hollywood * Δ Gravity	41139.52 (0.5437)	-3051.307 (0.9804)	49385.73 (0.3644)	236052.6 (0.0002)	-7791.387 (0.5953)
Ocean Downs * Δ Gravity	-229378.6 (0.0001)	-227340.3 (0.0307)	3171.605 (0.9452)	102920.0 (0.1979)	-18736.27 (0.1320)
Maryland Live * Δ Gravity	-480594.6 (0.0000)	-366019.8 (0.0021)	-3719.379 (0.9432)	74634.02 (0.4087)	78948.39 (0.0000)
Rocky Gap * Δ Gravity	-39262.92 (0.4677)	303612.4 (0.0022)	107688.5 (0.0132)	450357.2 (0.0000)	37140.16 (0.0015)
<i>n</i>	16,403	16,403	16,403	16,403	16,403
<i>R</i> <sup>2</sup>	0.261405	0.151262	0.261922	0.437304	0.337682

<sup>a</sup> The constant coefficients reported are the average of the fixed effects coefficients in the regression.

<sup>b</sup> *p*-values are shown in parentheses.

**Table 4.** Estimated annual impact of all Maryland casinos on lottery sales, by game type (\$ millions)

	<b>Instant</b>	<b>Monitor</b>	<b>Pick</b>	<b>Multi-St</b>	<b>Other</b>	<b>Total, All Games</b>
Actual Last Year Sales (3/2013 – 2/2014)	\$471.2	\$472.5	\$515.3	\$223.2	\$58.63	\$1,740.8
Estimated Casino Impact	(\$12.44) -2.64%	(\$24.24) -5.13%	(\$4.04) -0.78%	(\$5.47) -2.45%	\$2.09 3.56%	(\$44.10) -2.53%
95% Confidence Interval, Lower Bound	(\$14.81) -3.14%	(\$28.58) -6.04%	(\$5.93) -1.15%	(\$8.76) -3.92%	\$1.58 2.69%	(\$56.48) -3.24%
95% Confidence Interval, Upper Bound	(\$10.08) -2.14%	(\$19.91) -4.21%	(\$2.14) -0.42%	(\$2.19) -0.98%	\$2.60 4.44%	(\$31.72) -1.82%

**Table 5.** Estimated annual impacts of individual Maryland casinos on lottery sales, by game type (\$ millions)

	<b>Instant</b>	<b>Monitor</b>	<b>Pick</b>	<b>Multi-St</b>	<b>Other</b>	<b>Total, All Games</b>
Actual Last Year Sales (3/2013 – 2/2014)	\$471.2	\$472.5	\$515.3	\$223.2	\$58.63	\$1,740.8
Hollywood Casino Impact	\$2.56 0.54%	(\$3.01) -0.64%	(\$0.86) -0.17%	(\$1.51) -0.68%	(\$0.16) -0.27%	(\$2.98) -0.17%
Ocean Downs Impact	(\$0.66) -0.14%	(\$2.11) -0.45%	(\$0.51) -0.10%	(\$1.17) -0.52%	\$0.11 0.18%	(\$4.55) -0.26%
Maryland Live Impact	(\$13.99) -2.97%	(\$20.03) -4.24%	(\$3.83) -0.74%	(\$9.29) -4.16%	\$2.90 4.95%	(\$44.24) -2.54%
Rocky Gap Impact	\$0.30 0.06%	\$0.61 0.13%	\$0.04 0.01%	\$0.58 0.26%	\$0.16 0.28%	\$1.70 0.10%
Total Estimated Impacts	(\$11.78) -2.50%	(\$24.54) -5.19%	(\$5.16) -1.00%	(\$11.39) -5.10%	\$2.80 4.77%	(\$50.07) -2.88%

**Table 6.** Forecasted annual impact of two new casinos on lottery sales, by game type (based on Maryland Live marginal impact results from Table 3) (\$ millions)

	<b>Instant</b>	<b>Monitor</b>	<b>Pick</b>	<b>Multi-St</b>	<b>Other</b>	<b>Total, All Games</b>
Actual Last Year Sales (3/2013 – 2/2014)	\$471.2	\$472.5	\$515.3	\$223.2	\$58.63	\$1,740.8
Horseshoe Casino, Baltimore Estimated Impact	(\$8.45) -1.79%	(\$12.09) -2.56%	(\$2.32) -0.45%	(\$5.61) -2.51%	\$1.75 2.99%	(\$26.72) -1.53%
MGM, National Harbor Estimated Impact	(\$5.90) -1.25%	(\$8.45) -1.79%	(\$1.62) -0.31%	(\$3.92) -1.75%	\$1.22 2.09%	(\$18.66) -1.07%
Horseshoe AND MGM Casinos Estimated Total Impact	(\$14.35) -3.05%	(\$20.54) -4.35%	(\$3.93) -0.76%	(\$9.52) -4.27%	\$2.98 5.07%	(\$45.38) -2.61%