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# JACKPOT ROLLOVER AND LOTTERY REGRESSIVITY

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## ABSTRACT

The majority of earlier studies have found the lottery to be a regressive form of taxation that varies by game and whose regressivity declines at higher jackpot size. This paper conducts an in-depth analysis of the effect of consumer spending on lottery regressivity during the Mega Millions rollover sequence and reports the following findings. First, regressivity among six games examined in the paper varies by game and is inversely related to the prize/jackpot size of the game. Second, an increase in the jackpot size reduces the regressivity for the Mega Millions game, but not for the other five games. Third, the impact of household income distribution on lottery sales varies by game, and in the case of Mega Millions, by jackpot size as well. We did not find a significant difference in the demand for the Mega Millions game between below middle-income households and high-income households. However, the demand by middle and upper-middle income households is significantly higher than the demand by high-income households, especially at a higher jackpot size. Lastly, as the jackpot size grows over $100 million and higher, a large cash inflow from states with no Mega Millions flows into the New Jersey lottery market. The majority of the additional cash inflow is spent on the Mega Millions game and there does not appear to be a significant spillover to other New Jersey lottery games.

**Keywords:** Mega millions, instant games, regressivity, rollovers, income elasticity, jackpot

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# 1 INTRODUCTION

The Mega Millions, a multi-state jackpot game, began on August 31, 1996 as the "Big Game" and in May 2002, it was given the new name of "Mega Millions." The first Mega Millions drawing took place on May 17, 2002 with nine states participating in the game. Today, 44 states, the District of Columbia, and the U.S. Virgin Islands offer the Mega Millions jackpot game.

In 2015, $2.2 billion of Mega Millions game tickets were sold, which was a decline of 13.42 percent from 2014 ticket sales of $2.54 billion. On a per capita basis (18 years and up), U.S. consumers spent around $9.40 on Mega Millions in 2015.[1] On a per capita basis, consumers from the State of New Jersey spent the largest amount at $19.41, followed by New York and Maryland at $16.48 and $14.38, respectively. On the other hand, consumers from Wisconsin, West Virginia and Wyoming spent the least at $4.07, $3.85 and $3.32, respectively. In terms of total ticket sales, consumers from the State of California spent the most at $390 million, followed by New York and Texas at $256 million and $137 million, respectively.

To participate in a Mega Millions game, players purchase a Mega Millions ticket for $1. The ticket allows players to pick five numbers from 1 to 75 and one Mega Ball number from 1 to 15; alternatively, the computer may randomly select numbers for you. Players win the jackpot prize by matching all six winning numbers in a drawing. Mega Millions draws are held bi-weekly on Tuesday and Friday at 23:00 ET. The jackpot starts at a minimum of $15 million and the odds of winning the jackpot prize is 1 to 258,890,850. If there are multiple winners, the jackpot prize is divided equally among them. If there are no winners, the current jackpot is rolled over and added to the funds from ticket sales in the next drawing. Since the Mega Millions does not have a rollover limit, this process will continue until there is an eventual winning ticket. If there are no winners over a month, the jackpot prize will approach $100 million. The actual jackpot prize depends on ticket sales; however, at each rollover, it will increase by a minimum of $5 million. In addition to the jackpot prize, there are eight other ways of winning a prize in the Mega Millions game. Hence, the overall odds of winning a prize on the Mega Millions game is 1 to 14.7 and the prize ranges from the jackpot to $1. By paying an additional $1, a player can participate in "Megaplier" and increase his/her non-jackpot prize winning by 2, 3, 4, or 5 times.[2]

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[1] Based on residents residing in 46 states/jurisdictions with lottery games. Due to the cross-border purchases by residents from states without lottery games, per capita sales are slightly overstated.

[2] Megaplier is the add-on-feature to the Mega Millions game that allows the non-jackpot prize winners to increase their winning prize by 2, 3, 4 and 5 times. Until January 31, 2010 Texas was the only state that offered Megaplier. Today, except for California, all lottery offering states participate in Megaplier.

The largest jackpot in Mega Millions game history took place on March 30, 2012. After 18 rollovers, on the 19th drawing, three winning tickets from Illinois, Kansas and Maryland claimed a jackpot prize of $656 million ($218.6 million each). Table 1 provides draw-by-draw analysis of the March 30, 2012 winning drawing. The first drawing took place on January 27, 2012 with a minimum prize amount of $12 million.[3] For the first eight drawings, ticket sales remained steady at around $20 million for each drawing with a small fluctuation between draws. Total ticket sales for the first eight drawings was at $165 million and the jackpot reached $72 million. Starting with the 9th drawing, ticket sales experienced a significant increase. By the 13th drawing, cumulative ticket sales were close to $350 million and by the 16th drawing, cumulative ticket sales exceeded $500 million. During the three-day span from the 18th to the 19th drawing, consumers spent an additional $652 million on Mega Millions game tickets. When it was all over, consumers spent in total $1.49 billion in Mega Millions game tickets from January 27, 2012 to March 30, 2012. Over 88 percent of the total ticket sales came after the 8th drawing.

**Table 1**

Draw-by-draw analysis of March 30, 2012 $656 million jackpot winning drawing (the largest Mega Millions jackpot in history). Total ticket sales do not include Megaplier sales.

| Drawing Date | Drawing sequence | Total ticket sales on each draw ($) | Cumulative ticket sales ($) | Jackpot level ($ millions) |
|---|---|---|---|---|
| 1/27/2012 | 1st | 18,165,511 | 18,165,511 | 12[a] |
| 1/31 | 2nd | 17,274,916 | 35,441,427 | 15 |
| 2/3 | 3rd | 19,843,752 | 55,285,179 | 23 |
| 2/7 | 4th | 19,361,572 | 74,646,751 | 32 |
| 2/10 | 5th | 22,222,098 | 96,868,849 | 41 |
| 2/14 | 6th | 21,548,361 | 118,417,210 | 51 |
| 2/17 | 7th | 23,255,125 | 141,672,335 | 61 |
| 2/21 | 8th | 22,835,162 | 164,507,497 | 72 |
| 2/24 | 9th | 26,363,391 | 190,870,888 | 83 |
| 2/28 | 10th | 28,218,276 | 219,089,164 | 94 |
| 3/2 | 11th | 36,910,446 | 255,999,610 | 108 |
| 3/6 | 12th | 39,934,885 | 295,934,495 | 127 |
| 3/9 | 13th | 46,020,464 | 341,954,959 | 148 |
| 3/13 | 14th | 49,925,735 | 391,880,694 | 171 |
| 3/16 | 15th | 66,658,484 | 458,539,178 | 200 |

[3] Initial jackpot prize was $10 million from May 21, 2002 to July 22, 2005. It increased to $12 million from July 26, 2005 to October 18, 2013 and to the current level of $15 million from October 19, 2013.

| | | | | |
|---|---|---|---|---|
| 3/20 | 16th | 78,423,325 | 536,962,503 | 241 |
| 3/23 | 17th | 111,282,952 | 648,245,455 | 290 |
| 3/27 | 18th | 190,922,875 | 839,168,330 | 363 |
| 3/30 | 19th | 651,915,940 | 1,491,084,270 | 656 |

Source: www.LottoReport.com

a. Initial jackpot prize for Mega Millions was $10 million from May 21, 2002 to July 22, 2005. It increased to $12 million from July 26, 2005 to October 18, 2013 and to the current level of $15 million from October 19, 2013.

From Table 1, it is clear that as Mega Millions continues to roll over without a winning ticket, significant additional cash flows into the lottery.[4] Starting with the 9th drawing, successive rollover resulted in larger amount of Mega Millions game ticket sales than before. As consumer spending increases by a greater amount with each successive rollover, the issue of lottery regressivity takes on a greater significance for society. Lottery opponents are concerned that those who can least afford to play account for the highest percentage of lottery purchases, and therefore the heaviest financial burden is placed on the poor than on the wealthy. The majority of studies on lottery regressivity found the lottery to be a regressive form of taxation. However, Clotfelter and Cook (1987) and Oster (2004) found lottery regressivity to decline at higher jackpot sizes. Clotfelter and Cook (1987) reported that when jackpots become very large, the income distribution of lotto players apparently changes. When the jackpot gets very large, expenditures rise proportionally faster than income for all income classes except for the highest income class. Oster (2004) also found decreasing regressivity of the multi-state lotto game as the jackpot size increased, suggesting that the lotto game is less regressive at higher jackpot levels.

The purpose of the current study is to extend the existing literature by estimating lottery regressivity throughout the Mega Millions rollover sequence for six out of eight lottery games sponsored by the State of New Jersey.[5] By estimating lottery regressivity throughout the rollover sequence, our study will allow us to examine the stability of each game's regressivity from the first to the wining drawing. This will allow us to examine if the regressivity remains constant or varies during the rollover process. If there is a change in regressivity, we will examine the magnitude of the change as well as the jackpot level that initiates sizeable changes in regressivity. We will also examine lottery regressivity for total lottery sales. If the regressivity for total lottery sales changes during the rollover sequence, we will investigate which

[4] The cash inflow pattern exhibited in Table 1 represents cash inflow pattern on the rest of Mega Millions winning drawings with large jackpot.

[5] Lottery sales for Extra 3 and Extra 4 were small. Thus, they are not included in the analysis.

game(s) accounts for the change. The impact of household income distribution on lottery sales will also be examined. We are interested in learning whether the impact of household income distribution on lottery sales is the same for the six games included in the sample and if the impact remains constant throughout the rollover process. Lastly, the State of New Jersey is bordered by three states. During the sample period, all three states offered lottery games to their residents, but only one state, New York, offered the Mega Millions game to their residents. Thus, it is possible that as the jackpot size gets large, residents from neighboring states cross over to New Jersey to purchase Mega Millions game tickets. We will conduct an in-depth analysis of cross-state border purchases throughout the rollover sequence.

The remainder of the paper is organized as follows. Section II provides a literature review. Section III describes the data and the methodology. Section IV discusses empirical results and cross-state border results are presented in Section V. The last section summarizes and concludes the paper.

## 2 LITERATURE REVIEW

Given the significance of implications of lottery regressivity on the society, a large number of studies have examined lottery regressivity. A first set of studies examined whether the lottery is indeed regressive and if the regressivity varies across lottery products. The majority of studies on lottery regressivity found that the lottery is a regressive form of taxation and varies across lottery products. Stranahan and Borg (1998) found that although both the Instant Games and Lotto games in Florida, Virginia, and Colorado are regressive, the Instant Games are more regressive than Lotto games in those states. Price and Novak (1999) reported that the estimated coefficients on income elasticity are all significantly less than one indicating that all three Texas lottery games are regressive. Across lottery games, the Instant Game is the most regressive while the Lotto game is the least regressive. Additional studies by Jackson (1994), Kearney (2005), Guryan and Kearney (2008), Combs, Kim and Spry (2008), and Ghent and Grant (2010) also confirmed lottery regressivity and regressivity varying across games. Garrett (2012) examined lottery Instant Games by ticket prices and found that the income elasticities of demand for higher-priced instant tickets were less regressive than lower-priced tickets. Mikesell (1989) is one of the few studies that did not find evidence of tax regressivity. Using annual data for a subset of Illinois counties from 1985 to 1987, he found income elasticities that did not differ statistically from one. Pérez and Humphreys (2011) examined national survey data on lottery spending by Spaniards and found income elasticities of greater than one suggesting that the lottery is not regressive in Spain.

A small number of studies examined the stability of lottery regressivity over time. Jackson (1994) examined lottery sales in 1983 and 1990 for each city and town in Massachusetts. His findings suggest that the lottery went from being progressive in 1983 to regressive in 1990. Garrett and Coughlin

(2009) estimated annual income elasticities of demand for lottery tickets for three states from 1987 to 2005 and also found them to be changing over time. In a related study, Garrett and Kolesnikova (2015) adjusted lottery sales and income by locational cost of living and found for both instant sales and online sales the real-income elasticity to be greater than the nominal-income elasticity. The difference in the nominal and real income elasticities was more pronounced for instant lottery sales.

Another set of studies examined lottery regressivity and jackpot size. Clotfelter and Cook (1987) reported that income distribution of lotto players apparently changes when the jackpot becomes very large. They examined relative expenditures by income class for drawings when jackpot exceeded $5 million. They found that except for the highest income class, expenditures rise proportionally faster than income, suggesting a progressive incidence over this range. Oster (2004) examined daily Powerball lotto sales for each retailer in the State of Connecticut between 1999 and July 2001. She found decreasing regressivity of the lotto game with increasing jackpot size, suggesting that lotto game is significantly less regressive at higher jackpot levels.

## 3 DATA AND METHODOLOGY

### A. Data

From the first drawing on May 17, 2002 to December 29, 2015, there were 1,422 Mega Millions drawings. Of the 1,422 drawings, there were 161 winning drawings. In 156 of these, there was no winner in the first drawing and the jackpot was rolled over and added to the next drawing. For this study, our sample include Mega Millions drawings from March 2005 to January 2010.[6] During the sample period, there were 59 winning drawings including 29 drawings with a jackpot prize of at least $100 million. Our sample consists of these 29 winning drawings with a jackpot size of at least $100 million. These 29 winning drawings, with each winning drawing rolled over at least eight times, will allow us to examine lottery regressivity deep into the rollover sequence. The average number of rollovers for our sample was approximately 12 times and the average jackpot was $197.07 million. During the sample period, the largest winning prize of $390 million took place on March 6, 2007

[6] We restricted the sample from March 2005 to January 2010 for the following two reasons. First, we have weekly lottery sales data by zip code beginning in 2005. Second, New Jersey began selling Powerball tickets on January 31, 2010. We wanted to examine Mega Millions drawings prior to the introduction of Powerball game in New Jersey to focus on one jackpot game instead of two potentially competing jackpot games.

and it rolled over 15 times. The greatest number of rollovers for a winning drawing was 16 times and it occurred once on November 15, 2005.[7]

The weekly lottery sales for all games by zip code for the entire State of New Jersey was obtained from the Department of Treasury of the State of New Jersey. During the sample period, the State of New Jersey offered the following eight lottery games: Pick-3, Pick-4, Pick-6, Instant, Jersey Cash 5, Mega Millions, Extra 3, and Extra 4. From the 2010 US census data, the socio-demographic data on New Jersey residents residing in 595 zip codes was collected. Lottery sales data was matched with 2010 census data and if there was no match (or insufficient information), that observation (zip code) was dropped. This matching process resulted in retaining 484 observations for the analysis.[8]

Table 2 reports per capita total lottery sales and per capita sales for six out of eight lottery games offered by the State of New Jersey from the 1st through 8th rollover week.[9] Per capita total lottery sales at the end of the first rollover week was $6.91. The Instant Games with per capita sales of $3.75 accounted for 53.53 percent of per capita total lottery sales, followed by Pick-3 at 15.85 percent, Pick-4 at 9.53 percent, and Mega Millions at 8.56 percent. There does not appear to be a significant increase in per capita total lottery sales for the next three rollover weeks. However, starting with the 5th rollover week, each rollover leads to a large increase in per capita total lottery sales. By the 8th rollover week, per capita total sales increased from $6.91 to $9.79, an increase of 41.68 percent. Increase in sales of Mega Millions tickets accounted for 99.31 percent of the increase. At the 8th rollover week, per capita ticket sales for all games except for Mega Millions were around the same level as at the 1st rollover week. However, their share of per capita total lottery sales declined. For Instant Games, it declined from 53.53 percent to 36.65 percent. During the same time period, per capita sales of Mega Millions game increased from $0.50 to $3.36 and accounted for 36.09 percent of per capita total lottery sales. Therefore, as Mega Millions continues to roll over and the jackpot prize increases, consumer spending on lottery products rises sharply. Lottery players continue to spend similar amounts on other games but additional cash inflows into the lottery are spent almost entirely on the Mega Millions game. The effect of consumer spending on lottery regressivity during the Mega Millions rollover sequence will be examined next.

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[7] See Han, Lee, Suk and Sung (2016) for a detailed analysis of Mega Millions winning drawings with a minimum jackpot prize of $100 million.

[8] There were 63 zip codes with socio-demographic data but no matching lottery sales data. There were 37 zip codes with socio-demographic data but incomplete lottery sales data. In addition, there were 11 zip codes with missing socio-demographic data.

[9] Since we have weekly and not daily lottery sales data, we were not able to calculate statistics for each rollover. Instead, we computed statistics for each rollover week.

**Table 2**

Per capita (18 years and over) lottery sales ($) by game during the first through eighth rollover week. The sample includes 29 large Mega Millions winning drawings (jackpot prize ≥ $100 million) from 1/21/2005 – 1/29/2010.

| Rollover week | Average per capita lottery sales ($) by game. Number in parenthesis represents percentage of per capita total sales accounted by each game | | | | | | |
|---|---|---|---|---|---|---|---|
| | Total sales | Instant Games | Pick-3 | Pick-4 | Jersey Cash 5 | Pick-6 | Mega Millions |
| First | 6.91 | 3.75 (53.53) | 1.19 (15.85) | 0.70 (9.53) | 0.40 (6.31) | 0.30 (5.18) | 0.50 (8.56) |
| Second | 6.91 | 3.68 (52.72) | 1.21 (16.08) | 0.71 (9.52) | 0.42 (6.48) | 0.31 (5.31) | 0.55 (9.27) |
| Third | 7.03 | 3.71 (52.20) | 1.21 (15.79) | 0.71 (9.33) | 0.41 (6.28) | 0.31 (5.18) | 0.63 (10.51) |
| Fourth | 7.13 | 3.73 (51.49) | 1.20 (15.43) | 0.70 (9.13) | 0.40 (5.95) | 0.30 (4.95) | 0.75 (12.34) |
| Fifth | 7.48 | 3.75 (49.14) | 1.22 (14.83) | 0.71 (8.83) | 0.40 (5.65) | 0.30 (4.72) | 1.05 (16.05) |
| Sixth | 7.82 | 3.71 (46.32) | 1.20 (13.95) | 0.71 (8.35) | 0.38 (5.14) | 0.31 (4.62) | 1.46 (21.03) |
| Seventh | 8.67 | 3.71 (41.77) | 1.21 (12.88) | 0.70 (7.55) | 0.37 (4.39) | 0.33 (4.36) | 2.28 (28.35) |
| Eighth | 9.79 | 3.67 (36.65) | 1.27 (11.93) | 0.72 (6.91) | 0.37 (3.88) | 0.36 (4.23) | 3.36 (36.09) |

Source: State of New Jersey, Department of the Treasury, Division of State Lottery.

Before we proceed further, we would like to discuss several limitations that our data is subject to. First, due to the lack of individual-level data we rely on aggregate level data to estimate income elasticity. By using zip code data, we are implicitly assuming all consumers in the zip code to be homogeneous. Thus, our results measure responsiveness across zip codes rather than across individuals.[10] Second, we assume that zip code demographics are the same as purchaser demographics. That is, we assume no substantial across-zip code or across-state migration for ticket purchases. The State of New Jersey is bordered by Delaware, New York and Pennsylvania. During the sample period, these three states offered their own lottery games to their residents, but multi-state Mega Millions game was only available in New York. In the empirical results section, we will conduct an in-depth analysis of cross-state border purchases throughout the rollover sequence.

[10] Garrett (2016) raises serious concerns associated with using aggregate lottery data to make inferences on the behavior of individual consumers.

## B. Methodology

To estimate lottery regressivity throughout the rollover sequence, we ran a regression between per capita lottery sales and average family income. In addition to the average family income variable, we also included a set of control variables that were identified in the literature to have a statistically significant impact on lottery sales. To estimate lottery regressivity for each rollover week, the following equation is estimated separately for each lottery game[11],

$$
\begin{aligned}
LPCSALE_{i,j} = {} & \alpha_0 + \beta_1(LFAMINC_i) + \beta_2(POP_i) + \beta_3(EDU_i) \\
& + \beta_4(RACE_i) + \beta_5(OWNER_i) + \beta_6(DIVORCED_i) \\
& + \varepsilon_i \ (1)
\end{aligned}
$$

i (zip code) = 1, 2, …., 484
j (rollover week) = 2, 3, …, 8

where

| | |
|---|---|
| LPCSALE | is the natural logarithm of per capita lottery sales in $j^{th}$ rollover week in the district identified by zip code |
| LFAMINC | is the natural logarithm of average family income in the district identified by zip code[12] |
| POP | is the number of people in the 20 to 66 age group as a percentage of the total population in the district identified by zip code |
| EDU | is the number of people with a high school degree as a percentage of the total population 25 years and over in the district identified by zip code |
| RACE | is the total population of white persons as a percentage of the total population in the district identified by zip code |
| OWNER | is the natural logarithm of owner occupied housing units in the district identified by zip code |
| DIVORCED | is the number of people 15 years and over divorced as a percentage of the total population (15 years and over) in the district identified by zip code |
| ε | is the error term |

[11] Correlations among independent variables ranged from -0.426 to 0.526. The highest correlation is between *LFAMINC* and *RACE* at 0.526 followed by correlation between *LFAMINC* and *DIVORCED* at -0.426. The rest of the correlations are small and are available upon request.

[12] We also estimated (1) replacing LFAMINC with natural logarithm of per capita income (LPCINC) and obtained similar results. Correlation between LFAMINC and LPCINC is 0.976. Estimation results are available upon request.

## 4 EMPIRICAL RESULTS

We ran equation (1) for six lottery games sold by the State of New Jersey using data from the 1st through 8th rollover week to estimate income elasticities of demand throughout the rollover sequence.[13] The income elasticity will reflect how lottery ticket sales respond to changes in income at each rollover week. Table 3 presents results for the 1st rollover week. The estimated coefficients for the income variable are all negative and statistically significant at the 1 percent level. However, there is a significant difference in the estimated values between games. For per capita total lottery sales, the estimated value is -0.969. The estimated values for Instant Games, Pick-3 and Pick-4 are -1.104, -1.137 and -1.140, respectively. The estimated values for Jersey Cash 5, Pick-6 and Mega Millions game are -0.725, -0.303 and -0.342, respectively. Among the control variables, the estimated coefficient for education and owner-occupied housing units variables are negative and statistically significant at the 1 percent level. As the percentage of the population with a high school degree in an area increases, the demand for all lottery games declines. Similarly, as the percentage of the owner-occupied housing units in an area increases, the demand for lottery games also declines. The estimated coefficients for the rest of the control variables are not statistically significant. The F-statistic for the regression equation is significant at the 1 percent level.

The estimated income elasticity by game for the 2nd through 8th rollover week is presented in Table 4.[14] Based on the results presented in Table 4, we make the following three observations. First, all lottery games included in the current study are regressive. However, they differ in their degree of regressivity. Instant Games, Pick-3 and Pick-4 are the most regressive while Mega Millions is the least regressive. The regressivity for total lottery sales lies in between Instant Games and Mega Millions but is closer to that of Instant Games. Second, there appears to be an inverse relationship between the prize/jackpot size of the game and regressivity. During the sample period, the average prize/jackpot size for Pick-3, Pick-4, Jersey Cash 5, Pick-6 and Mega Millions games were $250, $2,500, $128,409, $7.08 million and $112.42 million, respectively.[15] The estimated income elasticity for the 8th

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[13] Throughout the rollover sequence, the number of observations (zip codes) included in the sample stays that same at 484; however, the number of winning drawings included in the sample varies. From the 1st to the 8th rollover, 29 winning drawings are included. On the 9th rollover, it declines to 28. On the 16th rollover, only one winning drawing is included in the sample. During the sample period, there was only one winning drawing that rolled over 16 times.

[14] The estimated coefficients for all other independent variables are not shown in Table 4. The full results are available upon request.

[15] There are different ways to play Pick-3 and Pick-4 games. The prize size for Pick-3 and Pick-4 are for 'Straight' game where the player attempts to match the winning numbers drawn in exact order.

rollover week for Pick-3, Pick-4, Jersey Cash 5, Pick-6 and Mega Millions are -1.146, -1.125, -0.776, -0.305 and -0.219, respectively. Lastly, estimated income elasticity for Instant Games, Pick-3, Pick-4, Jersey Cash 5 and Pick-6 remains stable throughout the rollover sequence. However, for Mega Millions and for per capita total lottery sales, the estimated income elasticity changes during the rollover sequence. For example, the estimated coefficient for Instant Games for the 1st rollover week is -1.104 and -1.090 for the 8th rollover week. Similarly, for the Pick-6 game, the estimated coefficients are -0.303 and -0.305 for the 1st and 8th rollover week, respectively. For Mega Millions, the estimated coefficient changes from -0.342 to -0.219, and for per capita total lottery sales, the estimated coefficient changes from -0.969 to -0.710.

**Table 3**

The effect of socio-demographic characteristics on lottery sales in New Jersey. The dependent variable is the natural logarithm of per capita lottery sales during the first rollover week. Standard errors are reported in parentheses (N = 484).

| Independent Variable | Coefficient estimates for the first rollover week | | | | | | |
|---|---|---|---|---|---|---|---|
| | Total sales | Instant Games | Pick-3 | Pick-4 | Jersey Cash 5 | Pick-6 | Mega Millions |
| Constant term | 13.613 | 14.275 | 13.838 | 13.622 | 7.479 | 2.209 | 3.599 |
| Income | -0.969*** (0.094) | -1.104*** (0.100) | -1.137*** (0.110) | -1.140*** (0.107) | -0.725*** (0.099) | -0.303*** (0.089) | -0.342*** (0.090) |
| Population | 0.669 (0.598) | 0.797 (0.636) | 0.563 (0.701) | 0.374 (0.683) | 0.272 (0.627) | 0.267 (0.569) | 0.616 (0.575) |
| Education | -0.941*** (0.315) | -1.003*** (0.335) | -0.921*** (0.369) | -1.029*** (0.360) | -1.025*** (0.330) | -0.666** (0.300) | -0.867*** (0.303) |
| Race | -0.160 (0.149) | 0.285 (0.159) | -1.184*** (0.175) | -1.063*** (0.171) | 0.296 (0.157) | 0.735*** (0.142) | 0.177 (0.144) |
| Marital status | -0.084 (1.152) | -0.607 (1.226) | 0.695 (1.351) | 0.441 (1.316) | 0.447 (1.208) | 1.152 (1.095) | -0.185 (1.108) |
| Owner occupied | -0.085*** (0.030) | -0.094*** (0.031) | -0.014 (0.035) | -0.036 (0.034) | -0.037 (0.031) | -0.085*** (0.028) | -0.088*** (0.028) |
| Adjusted $R^2$ | 0.327 | 0.299 | 0.457 | 0.454 | 0.148 | 0.086 | 0.063 |
| F-value | 40.106 | 35.403 | 68.830 | 67.860 | 15.014 | 8.543 | 6.441 |
| P(F-statistic) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

Asterisks denote significance at the 1% (***) and 5% (**) levels.

From Table 1 we observed that as the Mega Millions jackpot size gets larger, additional cash flows into the lottery, and according to Han, et al. (2016) study over 99 percent of this additional cash inflow is spent on the Mega Millions game. Therefore, we hypothesize that the decline in lottery regressivity for per capita total lottery sales from the 1st to 8th rollover week is due to the decline in Mega Millions' regressivity. To investigate this issue, a new dependent variable is created. The new dependent variable is per capita total lottery sales minus per capita Mega Millions sales. We re-estimated equation (1) with the new dependent variable and the results are presented in the last column in Table 4.[16] Excluding Mega Millions sales, per capita total lottery sales become more regressive and its estimated income elasticity remains constant throughout the rollover sequence. Thus, it appears that the Mega Millions game is the only lottery product whose regressivity declines with jackpot size while the other five games' regressivity do not vary with jackpot size. The other five games' income elasticities remain stable as the jackpot size increases from $12 million to over $200 million.

In addition to estimating income elasticities of demand, we also examined the relationship between the distribution of household income and lottery sales throughout the rollover sequence. The income elasticity captures lottery ticket sales' response to changes in income whereas the household income variable captures levels of lottery ticket expenditures by household with different incomes. To capture the distribution of household income on lottery sales, the following household income variables are included in equation (1): the percentage of zip code households having income less than $25,000 (low-income); the percentage of zip code households having income between $25,000 and $49,999 (lower-middle-income); the percentage of zip code households having income between $50,000 and $74,999 (middle-income); and the percentage of zip code households having income between $75,000 and $99,999 (upper-middle-income). The percentage of zip code households having income of $100,000 and higher (high-income) is omitted. To preserve space, only the results for the first, second, sixth, seventh and eighth rollover week for Instant Games, Pick-3, and Mega Millions are presented in Table 5.[17] These three games are selected since the first two have the highest per capita sales and Mega Millions game has the highest jackpot size.[18]

**Table 4**

Lottery regressivity for each game from the first through eighth rollover week. The dependent variable is the natural logarithm of per capita lottery sales for each rollover week. Standard errors are reported in parentheses (N = 484).

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[16] The estimated coefficients for all other independent variables are not shown in Table 4. The full results are available upon request.

[17] Correlation coefficients between average family income (*LFAMINC*) and household income variables are very high. For example, correlation coefficient between *LFAMINC* and high-income households is 0.95 and between *LFAMINC* and low-income households is -0.811. Hence, *LFAMINC* variable is dropped from the equation.

[18] Full results are available upon request.

| Rollover week | Income elasticity estimates from the first through eighth rollover week | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Total sales | Instant Games | Pick-3 | Pick-4 | Jersey Cash 5 | Pick-6 | Mega Millions | Total sales minus Mega Millions |
| First | -0.969*** (0.094) | -1.104*** (0.100) | -1.137*** (0.110) | -1.140*** (0.107) | -0.725*** (0.099) | -0.303*** (0.089) | -0.342*** (0.090) | -1.031*** (0.096) |
| Second | -0.947*** (0.093) | -1.087*** (0.100) | -1.121*** (0.110) | -1.120*** (0.106) | -0.719*** (0.099) | -0.292*** (0.089) | -0.299*** (0.091) | -1.018*** (0.095) |
| Third | -0.933*** (0.093) | -1.086*** (0.100) | -1.125*** (0.110) | -1.127*** (0.107) | -0.724*** (0.098) | -0.299*** (0.089) | -0.256*** (0.092) | -1.019*** (0.095) |
| Fourth | -0.921*** (0.092) | -1.094*** (0.099) | -1.131*** (0.110) | -1.129*** (0.107) | -0.731*** (0.099) | -0.303*** (0.089) | -0.229*** (0.092) | -1.026*** (0.095) |
| Fifth | -0.888*** (0.091) | -1.099*** (0.098) | -1.142*** (0.110) | -1.136*** (0.107) | -0.736*** (0.098) | -0.301*** (0.089) | -0.192** (0.093) | -1.031*** (0.095) |
| Sixth | -0.835*** (0.090) | -1.084*** (0.098) | -1.140*** (0.110) | -1.133*** (0.107) | -0.743*** (0.099) | -0.297*** (0.089) | -0.183** (0.092) | -1.023*** (0.094) |
| Seventh | -0.774*** (0.088) | -1.094*** (0.099) | -1.134*** (0.110) | -1.142*** (0.107) | -0.755*** (0.099) | -0.284*** (0.089) | -0.203** (0.092) | -1.025*** (0.095) |
| Eighth | -0.710*** (0.087) | -1.090*** (0.098) | -1.146*** (0.113) | -1.125*** (0.107) | -0.776*** (0.099) | -0.305*** (0.089) | -0.219** (0.091) | -1.020*** (0.094) |

Asterisks denote significance at the 1% (***) and 5% (**) levels.

As can be seen from the table, per capita Instant Games sales are higher in zip codes having a higher percentage of low, middle, and upper-middle income households relative to high-income households. Per capita Pick-3 game sales are higher in zip codes having a higher percentage of low, lower-middle, middle, and upper-middle income households relative to high-income households. However, for Mega Millions, only zip codes having a higher percentage of middle-income households experience higher sales relative to high-income households throughout the rollover sequence. In addition, at the 7th and 8th rollover week, zip codes having a higher percentage of upper-middle-income households also experience higher Mega Millions ticket sales relative to high-income households. On the other hand, starting with the 6th rollover week, zip codes having a higher percentage of lower-middle-income households experience lower Mega Millions ticket sales relative to high-income households, albeit at a lower significance level. Hence, based on results presented in Table 5, it appears that the impact of household income distribution on lottery sales varies by lottery game, and in the case of Mega Millions, by jackpot size as well.

**Table 5**

Distribution of household income and lottery sales by rollover week. The dependent variable is the natural logarithm of per capita lottery sales for each rollover week. Standard errors are reported in parentheses (N = 484).

| Rollover week | Coefficient estimates for household income variable[a] | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Instant Games | | | | Pick-3 | | | | Mega Millions | | | |
| | Low income | Lower-middle income | Middle income | Upper-middle income | Low income | Lower-middle income | Middle income | Upper-middle income | Low income | Lower-middle income | Middle income | Upper-middle income |
| First | 0.027***<br>(0.005) | 0.009<br>(0.007) | 0.039***<br>(0.008) | 0.041***<br>(0.009) | 0.032***<br>(0.005) | 0.015**<br>(0.007) | 0.033***<br>(0.009) | 0.038***<br>(0.010) | 0.006<br>(0.004) | -0.003<br>(0.006) | 0.023***<br>(0.007) | 0.016**<br>(0.008) |
| Second | 0.026***<br>(0.005) | 0.008<br>(0.007) | 0.040***<br>(0.008) | 0.041***<br>(0.009) | 0.031***<br>(0.005) | 0.015**<br>(0.007) | 0.033***<br>(0.009) | 0.038***<br>(0.010) | 0.006<br>(0.004) | -0.004<br>(0.006) | 0.022***<br>(0.007) | 0.014<br>(0.008) |
| Sixth | 0.026***<br>(0.005) | 0.009<br>(0.007) | 0.039***<br>(0.008) | 0.040***<br>(0.009) | 0.032***<br>(0.005) | 0.015**<br>(0.007) | 0.034***<br>(0.009) | 0.039***<br>(0.010) | 0.005<br>(0.004) | -0.010*<br>(0.006) | 0.022***<br>(0.007) | 0.013<br>(0.008) |
| Seventh | 0.026***<br>(0.005) | 0.009<br>(0.007) | 0.039***<br>(0.008) | 0.040***<br>(0.009) | 0.032***<br>(0.005) | 0.015**<br>(0.007) | 0.034***<br>(0.009) | 0.038***<br>(0.010) | 0.006<br>(0.004) | -0.011*<br>(0.006) | 0.023***<br>(0.007) | 0.016**<br>(0.008) |
| Eighth | 0.027***<br>(0.005) | 0.008<br>(0.007) | 0.040***<br>(0.008) | 0.041***<br>(0.009) | 0.033***<br>(0.005) | 0.015**<br>(0.008) | 0.035***<br>(0.009) | 0.036***<br>(0.010) | 0.007<br>(0.004) | -0.011*<br>(0.006) | 0.024***<br>(0.007) | 0.017**<br>(0.008) |

a. Household income variable is defined as follows. Low-income: percentage of zip code households having income less than \$25,000; Lower-middle-income: percentage of zip code households having income between \$25,000 and \$49,999; Middle-income: percentage of zip code households having income between \$50,000 and \$74,999; Upper-middle-income: percentage of zip code households having income between \$75,000 and \$99,999. The omitted group is zip code households with income ≥ \$100,000.
Asterisks denote significance at the 1% (***) and 5% (**) levels.

## 5 CROSS-STATE BORDER PURCHASE

The State of New Jersey is bordered by Delaware, New York and Pennsylvania. The State of New York introduced a state-sponsored lottery in 1967 and the Mega Millions game on May 17, 2002. Delaware and Pennsylvania introduced the lottery in 1975 and 1972, respectively, but the Mega Millions game was not introduced until January 31, 2010. Thus, during the sample period the Mega Millions game was available in New York but not in Delaware and Pennsylvania. This gives rise to the possibility that residents from Delaware and Pennsylvania may have crossed over to New Jersey to purchase Mega Millions game tickets, especially when the jackpot gets large. In our sample, there were 40 zip codes with complete data bordering Delaware or Pennsylvania.[19] To investigate a cross-state border effect, we conducted two additional tests. First, we created two sub-groups, 'State-border' and 'Non-state-border', and computed changes in per capital lottery sales for all games during the 2nd through 8th rollover weeks for these two sub-groups. Percentage change in per capital lottery sales is measured against per capita lottery sales data during the 1st rollover week. Table 6 presents mean percentage change in per capita total lottery sales, Instant Games sales, and Mega Millions game sales for 'Non-border' zip codes and for 'State-border' zip codes. As can be seen from the table, there is no statistical difference in percentage change in lottery sales between these two groups until the 5th rollover week. During the 5th rollover week, the percentage change in Mega Millions sales by state-bordering zip codes is 116.07 percent versus 104.99 percent for non-state bordering zip codes and the difference is significant at 1 percent level. The difference in percentage change in Mega Millions sales between these two groups gets larger and more significant as the jackpot continues to roll over. For per capita total lottery sales, the difference becomes significant during the 7th rollover week and it gets larger during the 8th rollover week. For Instant Games, there appears to be no significant difference between these two groups except at the 8th rollover week.

Second, we added a state-border indicator variable, SBORDER, to equation (1) and re-estimated entire results. SBORDER variable takes a value of 1 if a zip code is bordering either Delaware or Pennsylvania and 0, otherwise. Results are presented in Table 7.

According to results presented in Table 7, zip codes bordering another state experienced a significantly lower per capita lottery sales throughout the rollover sequence for all games, except for Mega Millions. In addition, the estimated coefficient for SBORDER variable remains stable throughout the rollover sequence for all games, except for Mega Millions. For example, the estimated coefficients for Instant Games at the 1st and 8th rollover week are -

[19] In total, there were 53 zip codes bordering either Delaware or Pennsylvania and one bordering both states. Fourteen of these zip codes did not have complete data and were dropped from the sample.

0.337 and -0.343, respectively. Both estimates are significant at the 1 percent level. The Mega Millions game also experienced a significantly lower per capita sales from the 1st to 5th rollover week. During the 6th and 7th rollover week, Mega Millions continued to experience lower per capita sales but the decline is not statistically significant. The estimated coefficient for SBORDER variable goes from -0.248 to -0.039 from the 5st to 7th rollover week. During the 8th rollover week, the estimated coefficient turns positive at 0.041. That is, in contrast to earlier rollover weeks, during the 8th rollover week state-bordering zip codes experienced a positive, albeit not statistically significant, increase in per capita Mega Millions game sales compared to non-state bordering zip codes.[20]

**Table 6**

Cross-state border significance test. Percentage change in mean per capita lottery sales during the second through eighth rollover week. Each week's change is measured against the lottery sales during the first rollover week. P-value is the significance level for the difference in mean test. There are 444 zip codes included in 'Non-border' zip codes and 40 zip codes are included in 'State border' zip codes.

| Rollover week | Percentage change in mean per capita lottery sales by game | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total sales | | | Instant Games | | | Mega Millions | | |
| | Non-border zip codes | State border zip codes | p-value | Non-border zip codes | State border zip codes | p-value | Non-border zip codes | State border zip codes | p-value |
| Second | 2.60 | 1.09 | 0.017 | 3.64 | 0.70 | 0.085 | 14.55 | 11.55 | < 0.001 |
| Third | 3.82 | 2.92 | 0.123 | 4.12 | 3.78 | 0.776 | 24.71 | 23.88 | 0.414 |
| Fourth | 5.86 | 4.96 | 0.190 | 4.60 | 4.26 | 0.791 | 49.12 | 51.48 | 0.186 |
| Fifth | 11.70 | 11.39 | 0.759 | 5.21 | 5.38 | 0.898 | 104.99 | 116.07 | 0.002 |
| Sixth | 19.06 | 19.59 | 0.760 | 5.85 | 6.30 | 0.730 | 187.14 | 226.82 | < 0.001 |
| Seventh | 34.97 | 41.47 | 0.042 | 8.13 | 8.76 | 0.742 | 350.97 | 496.14 | < 0.001 |
| Eighth | 58.14 | 77.59 | < 0.001 | 9.72 | 16.19 | 0.011 | 599.39 | 936.54 | < 0.001 |

Based on results presented in Tables 6 and 7, it appears that when the jackpot size is less than $100 million (i.e., during the 1st through 4th rollover week), there is no significant cross-state border migration to New Jersey to purchase lottery games. However, as the jackpot size grows over $100 million (around the 5th rollover week), it entices residents from Delaware and

[20] We also re-estimated entire results by dropping 40 state bordering zip codes. Compared to results from the full sample (Table 4), the estimated coefficients are slightly higher (in absolute terms) but the overall conclusions remain the same. Results are available upon request.

Pennsylvania to cross over to New Jersey to purchase Mega Millions tickets but no other New Jersey lottery products.[21] As the jackpot size grows even larger, a significantly larger cross-border purchase takes place. Almost all the additional money flowing into the New Jersey lottery from Delaware and Pennsylvania is spent on Mega Millions and there does not appear to be significant spillover to other New Jersey lottery games. Our result confirms Ghent and Grant's (2010) finding where counties in the State of South Carolina that border North Carolina (North Carolina did not have a state-sponsored lottery during their study period) experienced greater than average sales of lottery games compared to other counties.

**Table 7**

Cross-state border significance test. The dependent variable is the natural logarithm of per capita lottery sales for each rollover week. Standard errors are reported in parentheses (N = 484).

| Rollover week | Coefficient estimates for cross-border variable, SBORDER[a] | | | | | | |
|---|---|---|---|---|---|---|---|
| | Total sales | Instant Games | Pick-3 | Pick-4 | Jersey Cash 5 | Pick-6 | Mega Millions |
| First | -0.325***<br>(0.097) | -0.337***<br>(0.103) | -0.324***<br>(0.114) | -0.259**<br>(0.119) | -0.461***<br>(0.101) | -0.282***<br>(0.093) | -0.337***<br>(0.093) |
| Second | -0.333***<br>(0.096) | -0.349***<br>(0.102) | -0.322***<br>(0.114) | -0.278***<br>(0.110) | -0.466***<br>(0.101) | -0.292***<br>(0.092) | -0.354***<br>(0.094) |
| Third | -0.328***<br>(0.096) | -0.342***<br>(0.103) | -0.330***<br>(0.114) | -0.281***<br>(0.111) | -0.466***<br>(0.101) | -0.288***<br>(0.092) | -0.331***<br>(0.094) |
| Fourth | -0.324***<br>(0.095) | -0.346***<br>(0.102) | -0.335***<br>(0.114) | -0.287***<br>(0.111) | -0.465***<br>(0.101) | -0.289***<br>(0.092) | -0.298***<br>(0.096) |
| Fifth | -0.306***<br>(0.094) | -0.338***<br>(0.102) | -0.327***<br>(0.114) | -0.279***<br>(0.111) | -0.459***<br>(0.101) | -0.287***<br>(0.092) | -0.248***<br>(0.096) |
| Sixth | -0.282***<br>(0.093) | -0.335***<br>(0.101) | -0.334***<br>(0.114) | -0.280***<br>(0.111) | -0.464***<br>(0.101) | -0.276***<br>(0.092) | -0.171<br>(0.096) |
| Seventh | -0.228***<br>(0.092) | -0.346***<br>(0.102) | -0.323***<br>(0.114) | -0.273***<br>(0.111) | -0.450***<br>(0.101) | -0.268***<br>(0.092) | -0.039<br>(0.096) |
| Eighth | -0.163<br>(0.090) | -0.343***<br>(0.102) | -0.307***<br>(0.117) | -0.269**<br>(0.111) | -0.405***<br>(0.102) | -0.256***<br>(0.093) | 0.041<br>(0.096) |

a. Cross-border variable, SBORDER, takes a value of 1 if the zip code borders either Delaware or Pennsylvania and 0, otherwise.

Asterisks denote significance at the 1% (***) and 5% (**) levels.

[21] The average jackpot size for the 4th, 5th and 6th rollover weeks are $90.41 million, $124.85 million and $173.41 million, respectively for the 29 Mega Millions winning drawings included in the sample.

## 6 DISCUSSION AND CONCLUSION

During the March 2005 to January 2010 period, there were 29 Mega Millions winning drawings with a jackpot prize of at least $100 million. The average jackpot prize for these 29 winning drawings was $197.07 million and the average number of rollovers was approximately 12 times. As Mega Millions continues to roll over and the jackpot size gets larger, consumer spending on Mega Millions rises sharply without a concomitant increase for other lottery games. Throughout the rollover sequence, per capita spending on other lottery games remains very stable and the additional cash inflow into the lottery market is spent almost entirely on the Mega Millions game. The effect of consumer spending on lottery regressivity during the Mega Millions rollover sequence is analyzed in the current study.

Based on an in-depth analysis of 29 Mega Millions winning drawings with a jackpot prize of at least $100 million, we report the following findings. First, consistent with the majority of earlier studies, our study also finds lottery games offered in the State of New Jersey to be regressive. Regressivity among six games examined in the study varies by game and appears to be inversely related to the prize/jackpot size of the game. For example, the estimated income elasticity at the 6$^{th}$ rollover week for Instant Games, Pick-3, Pick-4, Jersey Cash 5, Pick-6 and Mega Millions are -1.084, -1.140, -1.133, -0.743, -0.297 and -0.183, respectively. During the sample period, the average prize/jackpot size for Pick-3, Pick-4, Jersey Cash 5, Pick-6 and Mega Millions games were $250, $2,500, $128,409, $7.08 million and $112.42 million, respectively. As the prize/jackpot size increases from $250 to $112.42 million, regressivity declines from -1.140 to -0.183. This finding is consistent and complements Oster (2004) and Garrett's (2012) findings.

Second, the jackpot size appears to reduce the regressivity of the Mega Millions game, but has negligible effect on the other five games. From the 1$^{st}$ to 8$^{th}$ rollover week the estimated income elasticity remains constant for all games, except for Mega Millions. For example, the estimated income elasticity for Instant Games for the 1$^{st}$ and 8$^{th}$ rollover week are -1.104 and -1.090, respectively. For Pick-3, they are -1.137 and -1.146 for the 1$^{st}$ and 8$^{th}$ rollover week, respectively. For Mega Millions, the estimated income elasticity does not remain constant but varies with the jackpot size. As the jackpot size increases with each rollover, Mega Millions becomes less regressive. For example, the estimated income elasticity for the 1$^{st}$ and 8$^{th}$ rollover week are -0.342 and -0.219, respectively. The estimated income elasticity for per capita total lottery sales also declines from -0.969 to -0.710 from the 1$^{st}$ to 8$^{th}$ rollover week. This decline is almost entirely due to the decline in Mega Millions' regressivity. Thus, the behavior of estimated income elasticity for six games examined in the paper appears to reflect changes in per capita spending on each game during the rollover process. For those games with no changes in per capita spending, there is no change in estimated income elasticity. For Mega Millions, the destination for over 99%

of the additional cash inflow, there is a significant change in estimated income elasticity.

Third, the impact of household income distribution on lottery sales varies by the type of lottery game, and in the case of Mega Millions, by jackpot size as well. For Instant Games and Pick-3, sales are higher in zip codes having a higher percentage of low, middle, and upper-middle income households relative to high-income households (households with income ≥ \$100,000). However, for Mega Millions, only zip codes having a higher percentage of middle-income households experience higher sales relative to high-income households throughout the rollover process. In addition, at the 7th and 8th rollover week, zip codes having a higher percentage of upper-middle-income households also experience higher Mega Millions sales relative to high-income households. On the other hand, starting with the 6th rollover week, zip codes having a higher percentage of lower-middle-income households experience a lower Mega Millions sales relative to high-income households, albeit at a lower significance level. Thus, there is no significant difference in the demand for Mega Millions between below middle-income households and high-income households. However, the demand for Mega Millions by middle and upper-middle income households are significantly higher, especially at a higher jackpot level, than the demand by high-income households.

Lastly, as the Mega Millions jackpot size grew over \$100 million between the 4th and 5th rollover week, there appeared to be significant cross-state border migration from Delaware and Pennsylvania to New Jersey to purchase Mega Millions game tickets. As the jackpot size increases, significantly larger additional out-of-state cash flows into the New Jersey lottery market. Most of the additional cash inflow is spent on Mega Millions without significant spillover to other New Jersey lottery games. This purchasing pattern is consistent with our expectation. Since both Delaware and Pennsylvania have their own state-sponsored lottery, there should be no incentive for their residents to purchase other New Jersey lottery games.

In conclusion, lottery products sold in New Jersey are regressive, but the degree of lottery regressivity varies by game. Mega Millions is the least regressive and its regressivity declines with jackpot size. As the Mega Millions' jackpot size grows larger, there is significant additional cash flow into Mega Millions with each rollover. This additional cash inflow derives mainly from middle and upper-middle income households and appears to reduce Mega Millions' regressivity. If Mega Millions can continue to attract and increase participation from households with discretionary income, its regressivity may decline even further.

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