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# ANALYSIS OF LARGE MEGA MILLIONS ROLLOVERS

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## ABSTRACT

From May 17, 2002 to December 30, 2014, there were 1,318 Mega Millions drawings and 153 were winning drawings. In 148 out of 153 winning drawings, there was no winner(s) in the first drawing and the jackpot prize was rolled over and added to the next drawing. Since the Mega Millions does not have a rollover limit, this process continues until there is an eventual winning ticket. As the jackpot prize approaches $100 million, significantly larger additional cash flows into the lottery. Based on the analysis of 29 large Mega Millions winning drawings (jackpot prize ≥ $100 million), we report the following findings. First, significantly larger additional money flows into the lottery as the jackpot prize gets larger, and over 90% of the additional cash inflow is spent on Mega Millions tickets. Second, for the entire sample there does not appear to be reallocating of funds taking place within lottery games. Third, zip-codes with a higher average family income or residents with more years of schooling experience a significantly higher demand for Mega Millions tickets. Furthermore, as the percentage of white or Asian-Americans in an area increase, the demand for Mega Millions increases by a significant amount. Lastly, as the jackpot prize gets larger, lottery players from all income levels spend more money on Mega Millions, but over 80% of the additional money comes from consumers belonging to the upper-middle or higher income brackets.

**Keywords:** Mega millions games, instant games, cannibalism, regressivity, income, zip codes

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# 1. INTRODUCTION

The Mega Millions, a multi-state jackpot game, began on August 31, 1996 as the "Big Game" and the first drawing took place on September 6, 1996 in six states. The state of New Jersey began offering the game to its residents in May 1999. In May 2002, New York and Ohio joined the existing seven states to create the Mega Millions and the first drawing took place on May 17, 2002. Today, 44 states, the District of Columbia, and the U.S. Virgin Islands offer the Mega Millions jackpot game.

In 2002, $1.69 billion of Mega Millions game tickets were sold. Mega Millions ticket sales grew to $3.2 billion in 2012 but declined to $2.54 billion in 2014. 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. 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.

From May 17, 2002 to December 30, 2014, there were 1,318 Mega Millions drawings. Of the 1,318 drawings, there were 153 winning drawings. In 148 of these, there was no winner in the first drawing and the jackpot prize was rolled over and added to the next drawing. Since the Mega Millions does not have a rollover limit, this process continues until there is an eventual winning ticket. As an illustration of this process, Table 1 provides draw-by-draw analysis of the March 6, 2007 $390 million jackpot winning drawing. The first drawing took place on January 12, 2007 with a minimum prize amount of $12 million.[1] By the 9th rollover, the jackpot level increased to $106 million. On the 10th rollover, the jackpot amount rose by $24 million, an increase of 22.64% from the previous drawing. On the 16th drawing, two winning tickets matched all six numbers and claimed $390 million prize ($195 million each). From the first to the winning drawing, the jackpot amount increased from $12 million to $390 million, a 3,150% increase. Approximately 80% of the increase came after the 7th rollover.

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

**Table 1: Draw-by-draw analysis of March 6, 2007 $390 million jackpot winning drawing.**

| Drawing Date | Jackpot level ($ millions) | Rollover sequence | Amount added by each rollover ($ millions) |
|---|---|---|---|
| 1/12/2007 | $12 | - | - |
| 1/16 | $16 | 1 | $4 |
| 1/19 | $25 | 2 | $9 |
| 1/23 | $33 | 3 | $8 |
| 1/26 | $43 | 4 | $10 |
| 1/30 | $54 | 5 | $11 |
| 2/2 | $65 | 6 | $11 |
| 2/6 | $77 | 7 | $12 |
| 2/9 | $91 | 8 | $14 |
| 2/13 | $106 | 9 | $15 |
| 2/16 | $130 | 10 | $24 |
| 2/20 | $150 | 11 | $20 |
| 2/23 | $177 | 12 | $27 |
| 2/27 | $216 | 13 | $39 |
| 3/2 | $275 | 14 | $59 |
| 3/6 | $390 | 15 | $115 |

Source: www.usamega.com

As discussed above, the jackpot starts with a minimum amount and if there are no winners for successive draws, significant additional money flows into the lottery. Each successive rollover generates larger cash inflows. As we examine lottery participants' reactions to Mega Millions rollovers, several issues came to our attention and they will be the focus of this paper. First, what is the size of the incremental cash inflow at each rollover and which game(s) benefits from additional money flowing into the lottery? Is the additional money spent mainly on the Mega Millions game or do other games benefit from a large jackpot prize? That is, do large jackpots generate a spillover effect to other games? Second, in addition to attracting new money into the lottery, do large jackpot prizes entice lottery players to reallocate funds from other games to Mega Millions? In other words, is there cannibalization taking place within lottery games? Third, with the exception of one zip code, all zip codes included in the sample experienced a positive increase in per capita Mega Millions sales. However, changes in per capita Mega Millions sales varied significantly across zip codes. For example, on the 5th week of rollover, changes in per capita Mega Millions sales ranged from 54% to 200% with an average increase of 105%. Hence, we will exploit the variation in changes in per capita Mega Millions sales to develop a profile of zip-codes that are most or least likely to participate in the Mega Millions game. Lastly, a major criticism advanced by lottery opponents in the US is 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. This raises the question of whether the lottery is a regressive form of taxation. By examining the share of Mega Millions tickets purchased across income distribution, we will investigate whether a regressive form of taxation is associated with Mega Millions sales.

The remainder of the paper is organized as follows. Section II provides a literature review. Section III describes the data and section IV performs an analysis of large Mega Millions winning drawings. Section V develops a profile of profile of zip-codes that are most or least likely to participate in the Mega Millions game. In addition, the section also examines whether regressive taxation is associated with Mega Millions sales. The last section summarizes and concludes the paper.

## 2. LITERATURE REVIEW

Earlier studies have examined the responsiveness of lottery sales to lotto rollovers and the corresponding large jackpot prizes. Clotfelter and Cook (1990) found lotto sales to be responsive to rollovers but varied widely from drawing to drawing. Survey respondents to Burns, Gillett, Rubinstein and Gentry (1990) study indicated that the amount they would spend on the lottery is directly related to jackpot size. As the jackpot size gets larger, their spending would also increase. Purfield and Waldon (1999) plotted lotto sales from 1993 to 1994 and found the plot drifting upward with each series of rollovers. Forrest, Simmons, and Chesters (2002) examined lotto sales in UK from 1997 to 1999 and found that a higher jackpot led to a significant increase in lotto sales. Garrett and Sobel (2004) also found that large jackpots stimulate lottery play.

As lottery sales respond positively to large jackpot prizes, researchers have also investigated the source of this additional cash inflow as well as the issue of a regressive form of taxation associated with lottery purchases. Clotfelter and Cook (1987) reported that when jackpots become very large, the income distribution of lotto players changes. Price and Novak (1999) found that as the percentage of the black population declines, the demand for the lotto also declines. In addition, they found that lotto sales are positively associated with education. Kearney (2005) found that higher-income players are more likely to purchase jackpot lotto games whereas low-income lottery players are more likely to bet on Instant Games.

The majority of the studies on lottery regressivity found that the lottery is a regressive form of taxation and varies across lottery products. 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

(Instant, Pick3 and Lotto) are regressive. Across lottery games, the Instant game is the most regressive while the Lotto game is the least regressive. Oster (2004) also found that the lottery is less regressive at higher jackpot levels. Additional studies by Jackson (1994), Kearney (2005), and Guryan and Kearney (2008) also confirmed lottery regressivity and regressivity varying across games. Garrett and Coughlin (2009) estimated annual income elasticities of demand for lottery tickets for three states and found them to be changing over time. Ghent and Grant (2010) found that each of the three types of games offered in the State of South Carolina were regressive but the degree of regressivity was different among these games. Garrett (2012) examined lottery instant games by ticket prices and found 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.

Substitution within lottery games have also been examined by earlier studies. Clotfelter and Cook (1990) examined the impact of the introduction of the lotto on sales of existing games. Their findings indicated that the money spent on the lotto was “new money” and did not hurt sales of existing games. Purfield and Waldon (1999) examined Irish data and found Lotto and Lucky Number betting to be complimentary. Price and Novak (1999) and Guryan and Kearney (2008) also found various lottery games in the US to be complementary products. Lin and Lai (2006) examined the substitute effects between Lotto and Big Lotto in Taiwan and their results revealed that no significant substitute or complementary relationship exists between them. Grote and Matheson (2006) reported that once lottery players are in the store to purchase multi-state game tickets, they also tend to purchase other games. On the other hand, Trousdale and Dunn (2014) examined six on-line Texas Lottery games from 2006 to 2009 and found them to be generally gross substitutes for one another. Of particular interest to the current study, they found a strong substitution pattern between Mega Millions and other games sold in Texas. Forrest, Gulley, and Simmons (2004) and Perez and Forrest (2011) also found limited cross-game effects in the United Kingdom and in Spain, respectively.

## 3. DATA

From May 17, 2002 to December 30, 2014, there were 1,318 Mega Millions drawings. For this study, our sample include Mega Millions drawings from March 2005 to January 2010.[2] During the sample period, there were 59 winning drawings including 29 drawings with a jackpot prize of at least $100 million. When the jackpot prize approaches $100 million (around 9th rollover), the incremental money flowing into the lottery gets significantly larger. We designate these 29 winning drawings as 'large Mega Millions winning drawings.' We chose to focus on large jackpot winning drawings since these large drawing are the most informative in terms of addressing issues raised in the paper.

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. We restricted our sample to zip codes with a population of at least 1,000. 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 and the minimum population requirement resulted in retaining 458 observations for the analysis.[3]

By using zip code data we are implicitly assuming all consumers in the zip code to be identical. In addition, we are assuming that zip code demographics are the same as the purchaser demographics. That is there is no substantial across-zip code or across-state migration for ticket purchases.[4] Lastly, our results measure responsiveness of across zip-codes and not across individuals.

## 4. ANALYSIS OF LARGE MEGA MILLIONS WINNING DRAWINGS

As stated earlier, there were 29 large Mega Millions winning drawings during the sample period. The average jackpot prize for large Mega Millions winning drawings was $197.07 million and the average number of roll over was approximately 12 times. The largest winning prize of $390 million took

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[2] We restrict 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 in order to focus on one jackpot game instead of two potentially competing jackpot games.

[3] There were 33 zip codes with lottery sales data but no matching socio-demographic data. There were 66 zip codes with socio-demographic data but no matching lottery sales data. Additional 27 zip codes were deleted due to minimum population requirement and the remaining 14 were dropped due to other insufficient data.

[4] Oster (2004) examined across-state migration for ticket purchases by excluding zip codes bordering another state and obtained similar results.

place on March 6, 2007 and it rolled over 15 times. The highest number of times a winning drawing was rolled over was 16 times and it occurred once on November 15, 2005.

Table 2 reports average jackpot prize for each rollover and the average incremental change in the jackpot prize from the previous draw for 29 large Mega Millions winning drawings. As discussed earlier, as the jackpot prize approaches $100 million, the additional cash coming into the lottery gets significantly larger.

**Table 2: Mega Millions rollover, average jackpot prize for each rollover, and average incremental change at each rollover. Data are based on 29 large (jackpot prize ≥ $100 million) Mega Millions winning drawings from 1/21/2005 – 1/29/2010.**

| Rollover sequence | Number of large winning drawings included in the sample | Average jackpot prize ($ million) | Average change in the jackpot prize from the previous draw ($ million) |
|---|---|---|---|
| 1 | 29 | $15.72[a] | $4.00 |
| 2 | 29 | $24.24 | $8.52 |
| 3 | 29 | $33.21 | $8.97 |
| 4 | 29 | $43.10 | $9.90 |
| 5 | 29 | $53.48 | $10.38 |
| 6 | 29 | $64.55 | $11.07 |
| 7 | 29 | $76.59 | $12.03 |
| 8 | 29 | $90.41 | $13.83 |
| 9 | 28 | $105.82 | $15.41 |
| 10 | 27 | $124.85 | $19.03 |
| 11 | 20 | $144.40 | $19.55 |
| 12 | 17 | $173.41 | $29.01 |
| 13 | 13 | $205.77 | $32.36 |
| 14 | 9 | $248.00 | $42.23 |
| 15 | 4 | $303.00 | $55.00 |
| 16 | 1 | $315.00 | $12.00 |

Source: State of New Jersey Lottery, Department of Treasury, Government Records Access Unit, 2011

a. Initial jackpot prize was $10 million from May 21, 2002 to July 22, 2005 and at $12 million from July 26, 2005 to October 18, 2013.

*a. Destination for Additional Cash Inflows*

From Table 2, we observed that as the Mega Millions continues to roll over and its jackpot prize gets larger, it attracts additional cash into the lottery market. To investigate which game(s) attracts this cash inflow, we computed weekly per capita lottery sales and changes in per capita lottery sales for the first through ninth rollover weeks.[5] A summary of results is presented in Table 3.[6] Total per capita lottery sales at the end of the first rollover week was $7.52. The Instant Games with per capita sales of $4.11 accounted for 54.72% of total per capita sales, followed by Pick-3 at 16.51%, Pick-4 at 9.90%, and Mega Millions at 7.47%. By the 8th rollover week, total per capita sales increased from $7.52 to $10.79, an increase of 43.62%. Increase in sales of Mega Millions tickets accounted for 98.32% of the increase. In fact, increase in lottery sales from the 3rd rollover week to the week of the winning drawing was almost entirely due to the increase in Mega Millions ticket sales. 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 total sales declined. For Instant Games, it declined from 54.72% to 37.73%. During the same time period, per capita sales of Mega Millions tickets increased from $0.56 to $3.78 and accounted for 35.06% of total per capita sales. Hence, as the Mega Millions continues to roll over and the jackpot prize gets larger, 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 Mega Millions game.

*b. Cannibalization within Lottery Games*

In Table 3, we reported that per capita ticket sales for all games except for Mega Millions remained at about the same level throughout the rollover process. Thus, for the entire sample it appears that there is no shifting of funds taking place within lottery games. However, it is possible for a subset of zip codes included in the sample to reallocate funds from other games to the Mega Millions game. To further investigate this issue, we analyzed the following two cases. First, for the first four rollover weeks, we have zip codes with declining per capita total sales compared to the per capita total sales during the first rollover week. Per capita changes in sales by game for these zip codes are presented in Table 4. From Table 4 we can observe that even when changes in per capita total sales is negative, changes in per capita Mega Millions sales for all zip codes are positive except for one. The majority of

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

**Table 3: Per capita (PC) lottery sales and changes in mean per capita lottery sales during first through ninth rollover weeks.**

| Panel A: Per capita lottery sales during the first through ninth rollover weeks | | | | | | | |
|---|---|---|---|---|---|---|---|
| Rollover week | Mean per capita (15 years and up) lottery sales | | | | | | |
| | Total PC sales | Instant | Pick-3 | Pick-4 | Pick-6 | Jersey Cash 5 | Mega Millions |
| First | $7.52 | $4.11 | $1.24 | $0.74 | $0.34 | $0.45 | $0.56 |
| Second | $7.53 | $4.05 | $1.26 | $0.75 | $0.35 | $0.46 | $0.61 |
| Third | $7.66 | $4.09 | $1.26 | $0.75 | $0.35 | $0.45 | $0.71 |
| Fourth | $7.78 | $4.11 | $1.25 | $0.74 | $0.34 | $0.44 | $0.85 |
| Fifth | $8.15 | $4.12 | $1.27 | $0.75 | $0.34 | $0.44 | $1.17 |
| Sixth | $8.54 | $4.08 | $1.24 | $0.75 | $0.36 | $0.42 | $1.64 |
| Seventh | $9.49 | $4.08 | $1.26 | $0.74 | $0.38 | $0.41 | $2.56 |
| Eighth | $10.79 | $4.07 | $1.32 | $0.76 | $0.41 | $0.40 | $3.78 |
| Ninth | $10.23 | $3.74 | $1.22 | $0.71 | $0.41 | $0.33 | $3.77 |

| Panel B: Changes in mean per capita lottery sales during first through ninth rollover weeks. Each week's change is measured against the first week of rollover data | | | | | | | |
|---|---|---|---|---|---|---|---|
| Rollover week | Changes in the mean per capita lottery sales and percentage of change accounted by each game | | | | | | |
| | Total PC sales change | Instant | Pick-3 | Pick-4 | Pick-6 | Jersey Cash 5 | Mega Millions |
| Second | $0.01 | -$0.06 (-526.27%) | $0.02 (177.05%) | $0.00 (28.21%) | $0.01 (89.18%) | $0.01 (103.81%) | $0.05 (435.70%) |
| Third | $0.15 | -$0.02 (-12.65%) | $0.02 (15.38%) | $0.00 (1.18%) | $0.01 (7.08%) | $0.01 (4.07%) | $0.14 (98.36%) |
| Fourth | $0.26 | -$0.01 (-2.26%) | $0.01 (4.23%) | $0.00 (-1.39%) | $0.00 (0.60%) | -$0.01 (-3.23%) | $0.28 (108.94%) |
| Fifth | $0.64 | $0.00 (0.64%) | $0.03 (4.00%) | $0.01 (1.29%) | $0.01 (0.79%) | -$0.01 (-1.13%) | $0.61 (95.85%) |
| Sixth | $1.02 | -$0.03 (-3.27%) | $0.00 (0.27%) | $0.00 (0.13%) | $0.02 (1.88%) | -$0.02 (-2.39%) | $1.08 (105.51%) |
| Seventh | $1.98 | -$0.03 (-1.61%) | $0.02 (1.03%) | $0.00 (-0.07%) | $0.04 (2.07%) | -$0.04 (-1.96%) | $1.99 (100.90%) |
| Eighth | $3.28 | -$0.04 (-1.24%) | $0.08 (2.52%) | $0.01 (0.42%) | $0.08 (2.31%) | -$0.04 (-1.36%) | $3.22 (98.32%) |
| Ninth | $2.71 | -$0.38 (-13.86%) | -$0.02 (-0.92%) | -$0.03 (-1.06%) | $0.08 (2.83%) | -$0.11 (-4.20%) | $3.21 (118.34%) |

the increase in per capita Mega Millions sales came from the decline in per capita Instant Games ticket sales. However, the decline in per capita Instant Games ticket sales was small, less than $0.20 per capita.

Second, for each rollover week, we have zip codes with changes in per capita Mega Millions sales that are greater than changes in per capita total lottery sales. Per capita changes in sales by game for these zip codes are reported in Panel A in Table 5. The majority of the difference in per capita sales is due to the decline in per capita sales of Instant Games, albeit by a small amount. In addition, there appears to be a small shifting of funds from the Jersey Cash 5 to the Mega Millions game.

**Table 4: Zip codes with a decline in per capita total lottery sales compared to per capita total lottery sales during the first rollover week.**

| Rollover week | Number of zip codes with decline in per capita total sales | Changes in $ per capita sales by game | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Total | Instant | Pick-3 | Pick-4 | Pick-6 | Jersey Cash 5 | Mega Millions |
| Second | 109 | -$0.12 | -$0.19 | $0.01 | 0 | $0.01 | $0.02 | $0.06 |
| Third | 47 | -$0.11 | -$0.19 | 0 | -$0.01 | 0 | 0 | $0.09 |
| Fourth | 20 | -$0.05 | -$0.13 | -$0.03 | -$0.01 | -$0.01 | -$0.01 | $0.13 |

Based on results presented in Tables 3, 4 and 5 (Panel A), there does not appear to be reallocating of funds within lottery games. However, when changes in per capita total sales is negative, or when changes in per capita total sales is less than changes in per capita Mega Millions sales, a small (less than $0.20 per capita) outflow of money from Instant Games to Mega Millions game appears to take place. In summary, as the jackpot prize gets larger, lottery participants continue to maintain their spending on other games while spending on Mega Millions tickets rises sharply.[7]

*c. Which game(s), if any, benefits from Mega Millions rollovers?*

When Mega Millions continues to roll over, additional cash flows into the lottery market. The majority of this additional cash inflows is spent on Mega Millions game. However, there are zip codes with changes in per capita total sales that is greater than changes in per capita Mega Millions sales. That is, in addition to spending more money on Mega Millions tickets, consumers from these zip codes are also purchasing more tickets for other games. Panel B in Table 5 presents zip codes with per capita changes in total sales that is greater than per capita changes in Mega Millions sales, the size of the difference in per capita sales, and changes in per capita sales by game.

According to the results presented in Panel B in Table 5, when changes in per capita total sales is greater than changes in per capita Mega Millions sales, the majority of the additional money is spent on Instant Games. This is consistent throughout the rollover weeks. Thus, in terms of ticket sales, it

[7] As mentioned earlier, Trousdale and Dunn (2014) found a statistically significant substitution taking place between Mega Millions and other on-line games operated by the Texas Lottery Commission (TLC). But they did not examine the cross-price elasticity of demand between off-line betting games such as scratch-offs (i.e., Instant Games) and Mega Millions.

appears that Instant Games benefits the most. However, the size of the spillover is small compared to the per capita Instant Games ticket sales.

**Table 5: Analysis of zip codes with changes in Mega Millions sales that are greater than changes in total lottery sales and vice versa. All sales are expressed in per capita basis.**

| Panel A: Analysis of zip codes with changes in per capita Mega Millions sales that are greater than changes in per capita total lottery sales | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Changes in $ per capita sales by game | | | | | | | |
| Rollover week | Zip codes with changes in Mega Millions sale greater than changes in total lottery sales | Changes in total sales minus changes in Mega Millions sales | Instant | Pick-3 | Pick-4 | Pick-6 | Jersey Cash 5 | Mega Millions |
| Second | 210 | -$0.11 | -$0.13 | $0.01 | 0 | $0.01 | $0.02 | $0.07 |
| Third | 160 | -$0.09 | -$0.10 | 0 | 0 | 0 | 0 | $0.11 |
| Fourth | 185 | -$0.08 | -$0.05 | -$0.01 | -$0.01 | 0 | -$0.01 | $0.24 |
| Fifth | 120 | -$0.09 | -$0.08 | 0 | 0 | 0 | -$0.01 | $0.56 |
| Sixth | 150 | -$0.08 | -$0.04 | -$0.02 | -$0.01 | $0.01 | -$0.03 | $0.96 |
| Seventh | 91 | -$0.11 | -$0.07 | 0 | -$0.01 | $0.03 | -$0.06 | $1.76 |
| Eighth | 62 | -$0.23 | -$0.21 | 0 | 0 | $0.05 | -$0.06 | $2.73 |
| Panel B: Analysis of zip codes with changes in per capita total lottery sales that are greater than changes in per capita Mega Millions sales | | | | | | | | |
| | | Changes in $ per capita sales by game | | | | | | |
| Rollover week | Zip codes with changes in total lottery sales greater than changes in Mega Millions sales | Changes in total sales minus changes in Mega Millions sales | Instant | Pick-3 | Pick-4 | Pick-6 | Jersey Cash 5 | Mega Millions |
| Second | 233 | $0.12 | $0.07 | $0.02 | $0.01 | $0.01 | $0.02 | $0.07 |
| Third | 275 | $0.09 | $0.07 | $0.01 | 0 | 0 | $0.01 | $0.12 |
| Fourth | 251 | $0.09 | $0.10 | $0.01 | 0 | 0 | -$0.01 | $0.24 |
| Fifth | 323 | $0.14 | $0.11 | $0.02 | $0.01 | 0 | -$0.01 | $0.51 |
| Sixth | 288 | $0.12 | $0.13 | 0 | 0 | $0.01 | -$0.02 | $0.90 |
| Seventh | 360 | $0.20 | $0.19 | $0.02 | 0 | $0.03 | -$0.05 | $1.69 |
| Eighth | 393 | $0.42 | $0.28 | $0.09 | $0.04 | $0.06 | -$0.04 | $2.76 |

For example, during the eighth rollover week, an additional $0.28 on a per capita basis was spent on Instant Games, which represented 6.9% of per capita

Instant Games ticket sold during the week. Thus, the spillover effect from large jackpot prizes appears to be small.

## 5. A PROFILE OF MEGA MILLIONS PLAYERS

All zip codes, except for one, included in the sample experienced a positive increase in per capita Mega Millions sales throughout the rollover weeks compared to the first week of rollover. However, per capita changes in Mega Millions sales varied significantly across zip codes. For example, at the 5th rollover week, changes in per capita Mega Millions sales from the first week of rollover ranged from 54% to 200% with an average increase of 105%. Hence, it appears that some zip codes are highly attracted to large jackpots while others are less so. In this section we will investigate if there are common socio-demographic characteristics that will help us develop a profile of zip-codes that are most or least likely to participate in the Mega Millions game.

To develop a profile of zip-codes that are most or least likely to participate in Mega Millions games, we examine the socio-demographic variables that were identified in the literature to have a statistically significant impact on lottery sales. To test the significance of socio-demographic variables on weekly Mega Millions sales in NJ, the following equation is estimated[8],

$$PCMEGA_{i,j} = \alpha_0 + \beta_1(INC_i) + \beta_2(POP_i) + \beta_3(EDU_i) + \beta_4(RACE_i) + \beta_5(EMP_i) + \beta_6(OWNER_i) + \beta_7(DIVORCED_i) + \epsilon_i \tag{1}$$

i (zip code) = 1, 2, …., 458
j (rollover week) = 2, 3, …, 8

where

| | |
|---|---|
| PCMEGA | is the percentage change in per capita Mega Millions sales in jth rollover week compared to the first week of rollover in the district identified by zip code |
| INC | is the number of families in the \$25,000 to \$75,000 income level as a percentage of total families in the district identified by zip code |

[8] Correlations among independent variables ranged from -0.360 to 0.501. The highest correlation was between DIVORCE and EMPLOYED at 0.501 followed by correlation between DIVORCE and INCOME at 0.454. Results for the entire correlation table are available upon request.

| | |
|---|---|
| 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 |
| EMP | is the number of people 16 years and over employed as a percentage of the total population (16 years and over in the labor force) in the district identified by zip code |
| OWNER | is the natural logarithm of owner occupied housing units in the district identified by zip code |
| DIVORCE | 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 |
| $\varepsilon$ | is the error term |

We ran equation (1) using data for 4th through 8th rollover week and obtained similar results and Table 6 (second column) presents results based on the 5th rollover week.[9] As the percentage of low to middle income families in an area increases, the demand for Mega Millions tickets declines and the decline is significant at the 1% level. As the percentage of the white population in an area increases, the demand for Mega Millions increases and the increase is significant at the 1% level. Similarly, as the percentage of those employed in an area increases, the demand for Mega Millions increases and the increase is significant at the 1% level. All other variables are not statistically significant. The F-statistic for the regression equation is significant ($p < 0.01$). As a comparison, we also ran equation (1) for per capita changes in total sales and the results are presented in the third column in Table 6. Given that the majority of changes in per capita total lottery sales is accounted for changes in per capita Mega Millions sales, it is no surprise that results based on changes in per capita total sales are very similar to results based on changes in per capita Mega Millions sales.

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9 We chose to report results based on 5th rollover week since the 5th rollover week results are based on 27 large winning drawings whereas the 6th rollover week results are based on 17 winning drawings. In addition, from the 4th rollover week to the 5th rollover week, there is a significant increase in the average jackpot prize ($34.44 million or 38% increase) and this increase will allow us to address issues raised in the paper. Results for other rollover weeks are available upon request.

**Table 6: The effect of socio-demographic characteristics on Mega Million sales in New Jersey. The dependent variable is the per capita percentage change in Mega Millions (total) sales compared to the first week's sales. Standard errors are reported in parentheses.**

| Variable | Dependent variable | |
|---|---|---|
| | Mega Millions sales | Total lottery sales |
| Constant | 0.078<br>(0.326) | 0.011<br>(0.088) |
| Income | -0.688***<br>(0.135) | -0.278***<br>(0.036) |
| Population | -0.177<br>(0.200) | -0.015<br>(0.054) |
| Education | -0.009<br>(0.106) | 0.019<br>(0.028) |
| Race | 0.291***<br>(0.048) | 0.060***<br>(0.013) |
| Employed | 1.281***<br>(0.320) | 0.222***<br>(0.086) |
| Owner occupied | -0.018<br>(0.011) | -0.006**<br>(0.003) |
| Marital status | 0.617<br>(0.404) | -0.073<br>(0.109) |
| Adjusted $R^2$ | 0.247 | 0.256 |
| F-value | 22.422 | 23.423 |
| P(F-statistic) | 0.000 | 0.000 |

**, *** significant at the 5% and 1% levels, respectively.

To further develop the profile, we replaced the INCOME variable with average family income (expressed in logarithm) in the zip code.[10] We also replaced the EDUCATION variable with average years of schooling in the zip code.[11] Lastly, we replaced the white population with other ethnic groups.

[10] Correlations between average family income and the rest of the independent variables were less than 0.50 except for correlation between average family income and EMPLOYED at 0.688 and between average family income and RACE at 0.526. We re-estimated dropping EMPLOYED and RACE variables and obtained similar results as reported in Table 7. Complete results are available upon request.

[11] Correlations between average years of schooling and the rest of the independent variables were less than 0.50 except for correlation between average years of schooling and EMPLOYED at 0.641 and between average years of schooling and INCOME at -0.544. We re-estimated dropping EMPLOYED and INCOME variables and obtained similar results as reported in Table 7. Complete results are available upon request.

We ran separate regressions with each new variable and the main results using 5th rollover week data are presented in Table 7.[12]

**Table 7: Robustness tests on the significance of socio-demographic characteristics on Mega Million sales in New Jersey. The dependent variable is the per capita percentage change in Mega Millions (total) sales compared to the first week's sales. Standard errors are reported in parentheses.**

| Variable[a] | Dependent variable | |
|---|---|---|
| | Mega Millions sales | Total lottery sales |
| Mean family income | 0.295***<br>(0.034) | 0.096***<br>(0.009) |
| Mean schooling | 0.098***<br>(0.013) | 0.025***<br>(0.003) |
| African-American | -0.242***<br>(0.031) | -0.085***<br>(0.018) |
| Asian-American | 0.458***<br>(0.155) | 0.075***<br>(0.028) |
| Hispanic/Latino | -0.601***<br>(0.069) | -0.124***<br>(0.019) |

**, *** significant at the 5% and 1% levels, respectively.

a. We ran separate regressions for each variables listed in the first column while controlling for other independent variables listed in equation (1).

Zip-codes with a higher average family income experience a significantly ($p < 0.01$) higher demand for Mega Millions tickets. As the average years of schooling increases, the demand for Mega Millions increases and the increase is significant at the 1% level. As the population of African-Americans or Hispanics/Latinos in an area increases, the demand for Mega Millions declines and the decline is significant at the 1% level. However, as the percentage of Asian-Americans in an area increases, the demand for Mega Millions increases and the increase is significant at the 1% level.

We also ranked changes in per capita Mega Millions sales and created two sub-groups: above- average and below-average areas. The above-average (below-average) group consists of zip codes with per capita change in Mega Millions sales that is at least one standard deviation above (below) the mean per capita change in Mega Millions sales for the entire sample. For the 5th rollover week, there were 73 and 65 zip codes in the above-average and below-average groups, respectively. Table 8 provides descriptive statistics for these two sub-groups and the last column provides p-values for the difference in mean test. According to Table 8, the above-average group resides in cities

[12] Estimated results for other independent variables as well as for other rollover weeks are available upon request.

with a smaller population; are slightly older than residents from the below-average group; and are largely white (80%) followed by Asian-Americans (7.2%). They have more years of schooling, more of them are employed, and their average income is twice as much as the average income of the below-average group.

**Table 8: Descriptive statistics of the demographic characteristics of zip codes with at least one standard deviation above and below the mean percentage change in Mega Millions lottery sales. P-value is the significance level for the difference in mean test. Data are from the 5th rollover week.**

| | +1 SD | -1SD | p-value |
|---|---|---|---|
| Additional per capita spending on Mega Millions relative to 1st week of rollover | | | |
| • $ amount | $0.62 | $0.36 | < 0.001 |
| • Percentage change | 139.18% | 73.25% | < 0.001 |
| Population | 12,600 | 27,258 | < 0.001 |
| Race | | | |
| • White | 80.23% | 48.93% | < 0.001 |
| • African-American | 4.41% | 30.99% | < 0.001 |
| • Hispanic/Latino | 4.77% | 25.98% | < 0.001 |
| • Asian-American | 7.19% | 2.14% | < 0.001 |
| Mean schooling (in years)[a] | 14.36 | 12.39 | < 0.001 |
| Employed | 92.36% | 87.84% | < 0.001 |
| Mean family income | $147,958 | $70,332 | < 0.001 |
| Mean age of the population (in years) | 39.74 | 36.38 | < 0.001 |
| Divorced | 7.66% | 8.83% | 0.006 |
| Owner occupied housing | 78.05% | 49.21% | < 0.001 |

Sources: State of New Jersey Lottery, Department of Treasury, Government Records Access Unit 2010 U.S. Census Data

a. High School graduate with no college exposure and Bachelor degree holder with no graduate exposure are assigned 12 and 16 years of schooling, respectively.

Lastly, we ran logit regressions where the dependent variable takes a value of 1 if a zip code belongs to the above-average group and 0, otherwise. Results from the logit regressions are very similar to results presented in Tables 6 and 7.[13] That is, areas with a higher income level, more years of schooling and more resident employment purchase significantly more Mega Millions tickets as Mega Millions continues to roll over. Areas with predominantly white or Asian-American population also experience a greater increase in Mega Millions sales. However, as the African-American or Hispanics/Latinos population in an area increases, there is a significant decline in the demand for Mega Millions tickets.

*a. Regressive Form of Taxation and Mega Millions Sales*

A major criticism advanced by lottery opponents in the US is 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. Studies by Blalock, Just and Simon (2007), Lang and Omori (2009), and Shinogle, Norris, Park, Volberg, Haynes and Stokan (2011) reported a negative relationship between income and total lottery sales. However, Kearney (2005) found that lottery regressivity varies across lottery products, and according to Oster (2004), lottery regressivity declines as the jackpot size increases. According to our findings, as the percentage of low to middle income families in an area increases, the demand for Mega Millions game declines and the decline is significant at the 1% level. On the other hand, as the average income level in an area increases, there is a significant increase in demand for Mega Millions tickets. We also found that the average family income of $147,958 for zip codes with an above-average percentage change in per capita Mega Millions sales is twice as large as the average family income of $70,332 for zip codes with a below-average percentage change in per capita Mega Millions sales. Hence, as Mega Millions undergoes successive rollovers, additional money flows into the lottery market and over 90% of the money is spent on Mega Millions tickets. Furthermore, it appears that a large portion of this additional money comes from areas with average family income that is in the upper-middle or higher income brackets. To further examine the relationship between income and Mega Millions demand, we separated total additional money spent on Mega Millions tickets by family income brackets. Table 9 provides the break-down.

As an example, we will discuss results for the 5th rollover week. During the 2nd through 5th rollover week, residents residing in 458 zip codes included in our sample spent approximately $3 million on Mega Millions tickets. Residents residing in the lowest income bracket, $25,000 - $49,999, spent $71,825 (2.39%); residents residing in the next income bracket, $50,000 - $74,999, spent $445,925 (14.86%); residents residing in the $75,000 -

[13] Results are available upon request.

$99,999 income bracket spent $847,510 (28.25%); and residents residing in the highest income bracket, $100,000 and higher, spent $1,634,800 (54.49%). While residents residing in the lower income brackets did purchase more Mega Millions tickets as the jackpot prize got larger, their spending was less than 20% of total spending. Instead, over 80% of the additional $3 million spent on Mega Millions tickets came from residents belonging to the upper-middle or higher income brackets. This pattern of spending by income groups is also observed in all other rollover weeks.

**Table 9: Additional spending on Mega Millions tickets by income group for each rollover week. Number in parenthesis represents percentage accounted by each income bracket.**

| Rollover week | Total additional spending | Family income bracket | | | |
|---|---|---|---|---|---|
| | | $25,000 - $49,999 | $50,000 - $74,999 | $75,000 - $99,999 | $100,000 and higher |
| Second | $410,094 | $9,978 (2.43%) | $62,453 (15.23%) | $108,479 (26.45%) | $229,184 (55.89%) |
| Third | $690,201 | $24,625 (3.57%) | $93,014 (13.48%) | $123,321 (17.87%) | $449.242 (65.09%) |
| Fourth | $1,390,548 | $32,608 (2.35%) | $206,670 (14.86%) | $386,310 (27.78%) | $764,960 (55.01%) |
| Fifth | $3,000,059 | $71,825 (2.39%) | $445,925 (14.86%) | $847,510 (28.25%) | $1,634,800 (54.49%) |
| Sixth | $5,310,569 | $128,476 (2.42%) | $799,243 (15.05%) | $1,516,290 (28.55%) | $2,866,560 (53.98%) |
| Seventh | $9,829,817 | $246,930 (2.51%) | $1,509,749 (15.36%) | $2,872,076 (29.22%) | $5,201,062 (52.91%) |
| Eighth | $15,899,779 | $415,941 (2.62%) | $2,503,377 (15.74%) | $4,698,905 (29.55%) | $8,281,557 (52.09%) |

Results presented in Table 9 are consistent with results presented in Table 7. Table 7 reports that the estimated coefficient for mean family income is 0.295 for Mega Millions sales and 0.096 for total lottery sales. Since mean family income is expressed in logarithm, it measures percentage change in Mega Millions sales (percentage change in total lottery sales) compared to the percentage change in mean family income. Our results suggest that Mega

Millions sales are less regressive than total lottery sales. Our result is consistent with Guryan and Kearney's (2008) findings that overall lottery sales in Texas are more regressive than Texas Lotto sales.

## 6. SUMMARY AND CONCLUSION

From May 17, 2002 to December 30, 2014, there were 1,318 Mega Millions drawings. Out of the 1,318 drawings, there were 153 winning drawings. In 148 out of 153 winning drawings, there was no winner in the first drawing and the jackpot prize rolled over and was added on to the next drawing. Based on a careful examination of 29 large Mega Millions drawings (jackpot prize ≥ $100 million) from March 2005 to January 2010, we report the following findings. First, as the jackpot prize gets larger, there is significant additional money flowing into the lottery market. On average, from the first drawing to the winning drawing (i.e., $15^{th}$ drawing), the jackpot amount increased from $12 million to $303 million, representing a 2,425% increase. Over 70% of the increase came after the $7^{th}$ roll over. Over 90% of the additional money was spent on Mega Millions tickets. When changes in per capita total lottery sales is greater than changes in per capita Mega Millions sales, the difference in cash inflows was spent mostly on Instant Games. However, the additional amount spent on Instant Games was small at $0.28 on a per capita basis. Hence, large jackpots did not appear to generate a spillover effect to other games.

Second, there does not appear to be shifting of funds within lottery games. That is, the large jackpot prize does not appear to entice lottery players to reallocate funds from other games to Mega Millions. To investigate this issue, we examined zip codes with a decline in per capita total sales relative to the first rollover week, and zip codes with per capita changes in Mega Millions sales that were greater than those in total lottery sales. In both cases, the majority of the difference in sales was due to a small decline (less than $0.20 on a per capita basis) in Instant Games sales. Overall, as the jackpot prize gets larger, lottery participants maintain their spending on other games while spending on Mega Millions tickets rises sharply.

Third, the current findings indicate that zip-codes with a higher average family income or residents with more years of schooling experience a significantly higher demand for Mega Millions tickets. In addition, as the percentage of white or Asian-Americans in an area increase, the demand for Mega Millions increases by a significant amount. However, as the population of African-Americans or Hispanics/Latinos in an area increases, the demand for Mega Millions declines by a significant amount. Our results are consistent with Price and Novak (1999) and Kearney (2005) findings.

Lastly, we also investigated whether a regressive form of taxation is associated with Mega Millions sales. Our results indicate that overall lottery sales in New Jersey is regressive but Mega Millions sales is less regressive than total lottery sales. Residents residing in the lower income brackets do purchase more Mega Millions tickets as the jackpot prize gets larger but their spending accounts for less than 20% of additional spending on Mega Millions. Instead, over 80% of the additional money spent on Mega Millions tickets came from residents belonging to the upper-middle or higher income brackets. Our results confirm earlier findings that the majority of the additional money spent on Mega Millions game come from players belonging to higher income brackets.

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