The Powerball Regressivity: An Evidence from the World’s Largest Lottery Prize

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Abstract

On January 13, 2016, the largest jackpot prize in world history took place. In this paper, we examined the Powerball’s regressivity from the 16th drawing with a jackpot of $301.8 million to the 20th drawing with a jackpot of $1.5 billion. These last five drawings allowed us to examine whether the regressivity continues to decline and turns progressive as jackpot levels approach the billion-dollar mark. Our sample include Powerball sales from 44 states and the DC. Since the cost of living varied across states/jurisdictions, we used real lottery and income data to estimate income elasticity. For the 16th through 18th drawings, there is a positive relationship between jackpot level and income elasticity. However, on the 19th drawing with a jackpot of $949.8 million, the income elasticity declined to 0.554 from 0.900. On the 20th drawing, the income elasticity increased to 0.649 but remained below 0.900 reached on the 18th drawing.
I. INTRODUCTION

On Saturday, November 7, 2015, the first drawing of the world’s largest jackpot prize in history took place. The Powerball rolled over nineteen times and on the 20th drawing on Wednesday, January 13, 2016, three lucky winners from California, Florida and Tennessee claimed the jackpot prize of $1.5864 billion. They all chose the cash option, and each winning ticket took home $245.875 million after paying 25% federal tax. Another factor working in the winners’ favor was that they all resided in states with no additional state tax on lottery prizes.1

The Powerball game began as Lotto*America on February 13, 1988. On April 19, 1992, it changed its name to “Powerball” and the first drawing as a Powerball game took place on April 22, 1992 with an initial jackpot prize of $2 million. Over time, there were many revisions to the format of the game and an additional thirty-three states in addition to the District of Columbia, Puerto Rico and Virgin Islands began selling Powerball game tickets. Today, to participate in the Powerball game, players purchase a Powerball ticket for $2. The ticket allows players to pick five numbers from 1 to 69 and one number from 1 to 26; alternatively, a player may fill in the “Quick Pick” to give you a computer-generated number selection. Players win the jackpot prize by matching all six winning numbers in a drawing. Powerball draws are held bi-weekly on Wednesday and Saturday at 10:59 PM ET. The jackpot starts at a minimum of $40 million and the odds of winning the jackpot prize is 1 in 292,201,338. 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 Powerball does not have a rollover limit, this process will continue until there is an eventual winning ticket. In addition to the jackpot prize, there are eight additional ways of winning a prize in a Powerball game. Hence, the overall odds of winning a prize on Powerball is 1 to 24.87 and the prize ranges from $4 to the jackpot prize.2 By paying an additional $1, a player can participate in “Power Play” and increase his/her non-jackpot prize winning by up to five times.3

From its introduction in 1992 to 2016, there have been three-hundred and two Powerball winning drawings. For ninety of these drawings, the jackpot prize was at least $100 million. The largest jackpot prize was the January 13, 2016 winning drawing. The second and third largest jackpot prizes were $590.5
million and $587.5 million drawn on May 18, 2013 and November 28, 2012, respectively. Mega Millions, the other multi-jurisdictional lottery game, was introduced in 1996. From its inception to 2016, there have been two-hundred and thirty-five winning Mega Millions drawings and seventy-five of them had the jackpot prize of at least $100 million. The largest Mega Millions jackpot prize in U.S. history was $656 million drawn on March 30, 2012. The second largest winning prize was $648 million drawn on December 17, 2013.

One of the major concerns with lottery gambling is that those who can least afford to play account for the highest percentage of lottery purchases. That is, the lottery is a regressive form of taxation. An extensive number of studies have examined issues related with lottery regressivity. Most of these studies found that lottery gambling is regressive but there is a substantial difference in the degree of regressivity among games. Lottery games with large jackpot prizes are less regressive than Instant games. In addition, they found an inverse relationship between jackpot size and regressivity. Furthermore, Oster (2004) examined the state of Connecticut Powerball sales from 1999 to July 2001 and made an out-of-sample prediction that at a jackpot of $806 million, the Powerball lottery will become progressive. However, the author advises caution with interpreting these results as it is often difficult to know how consumers will behave at jackpot levels of this magnitude.

Until the January 13, 2016 Powerball winning drawing, we were not able to examine consumer behavior at jackpot levels exceeding $800 million. As was noted above, the single largest winning drawing prior to the world’s largest winning drawing was the Mega Million’s $656 million in 2012. The January 13, 2016 winning drawing allows us to examine whether lottery regressivity continues to decline and, indeed, even turns progressive as jackpot levels approach the billion-dollar mark. On the other hand, it may be that as jackpot levels reach a billion dollars, there may be a significant change in the income distribution of lottery players such that the Powerball returns to being regressive.

The purpose of the current study is to examine the Powerball’s regressivity from the 16th drawing with an advertised jackpot of $301.8 million to the 20th, or winning, drawing with an advertised jackpot of $1.5 billion. Our focus is on the last five drawings since these drawings will allow us to examine lottery
regressivity at jackpot levels not examined in earlier studies. The last five drawings will allow us to examine if the regressivity continues to decline and turn progressive as jackpot levels approach the billion-dollar mark, or whether the inverse relationship between jackpot level and regressivity turns positive as jackpot levels reach a billion dollars. In addition to examining lottery regressivity around a billion-dollar jackpot level, we will also examine the cross-state border purchases at very high jackpot levels. Earlier studies have found that residents from non-lottery states cross over to purchase lottery tickets. During the sample period, there were six states that did not offer the Powerball game to their residents and ten states included in our sample had a border with at least one of these six states. Given the historical jackpot level and the media coverage generated, we expect that a substantial amount of cross-state border purchases took place. By examining the cross-state border purchases from the first to the winning drawing, we will be able to determine at what jackpot level a significant amount of money crossed state borders from non-Powerball states to states with Powerball game.

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. The last section summarizes and concludes the paper.

II. LITERATURE REVIEW

A substantial number of studies on lottery regressivity have found that the lottery is a regressive form of taxation and varies across lottery products. For example, Ghent and Grant (2010) found that three games offered by the state of South Carolina are all regressive with substantial differences in the degree to which each game is regressive. They found Lotto games to be less regressive than Instant games. A small number of studies such as those by Jackson (1994) and Garrett and Coughlin (2009) examined the stability of lottery regressivity over time and found the estimated annual income elasticity of demand for lottery tickets to vary with time.

Another set of studies examined lottery regressivity and jackpot size. Clotfelter and Cook (1987) reported that the income distribution of lotto players changes when the jackpot becomes very large. They examined relative expenditures by income class for drawings when the jackpot exceeded $5 million. They
found that except for the highest income class, expenditures rose 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 the lotto game is significantly less regressive at higher jackpot levels. Her out-of-sample prediction revealed that at a jackpot of $806 million, the lottery becomes progressive. However, she notes that her out-of-sample prediction should be interpreted with caution since it is difficult to know how people will behave at jackpot level of $806 million. Han, Lee, Suk and Sung (2017) examined 29 Mega Millions winning drawings with a jackpot prize of at least $100 million from March 2005 to January 2010. According to their findings, as the jackpot size increases with each rollover, Mega Millions become less regressive while the estimated income elasticity for the other five games included in their study remains constant.

III. Analysis of World’s Largest Jackpot Prize Winning Drawing

The first drawing for the world’s largest jackpot prize in history took place on November 7, 2015. There were no winners in the next 18 drawings. On the 20th drawing, three winning tickets claimed a jackpot prize of $1.5864 billion. Table 1 provides draw-by-draw analysis of the January 13, 2016 winning drawing. The first drawing started with a minimum jackpot prize of $40 million and it generated ticket sales of $26.45 million. On the 7th drawing, the jackpot prize reached $100 million and ticket sales for this drawing was $29.66 million, a small increase compared to the total ticket sales on the first drawing. When the jackpot prize increased to $202 million on the 13th drawing, consumers spent $50.72 million on Powerball tickets. On the 16th drawing, the jackpot prize increased to $301.8 million and there was a large rise in ticket sales compared to previous drawings. When the jackpot prize exceeded $500 million on the 18th drawing, it generated total ticket sales of $372.64 million. When the jackpot prize approached $1 billion for the first time in U.S. lottery history, it generated total ticket sales of $930 million. On the final drawing with an advertised jackpot prize of $1.5 billion, it generated total ticket sales of $1.34 billion. Total ticket sales during the last two drawings was $2.273 billion and accounted for 67.1% of total ticket sales generated from the first to the winning drawing. If we add the 18th drawing, total ticket sales increased to
$2.645 billion and accounted for 78.2% of total ticket sales from the first to the winning drawing. In the end, consumers spent in total $3.385 billion in Powerball game tickets from November 7, 2015 to January 13, 2016.

[Insert Table 1]

Comparing total Powerball ticket sales by state and jurisdiction from November 7, 2015 to January 13, 2016, we find that consumers from the state of California spent the most at $386 million, followed by Florida and Texas at $282.5 million and $268.8 million, respectively. On a per capita basis (18 years and up), consumers from the state of New Jersey spent the largest amount at $21.15, followed by Delaware and New Hampshire at $19.03 and $18.08, respectively. On the other hand, consumers from Washington, Oregon, and Illinois spent the least at $10.17, $10.43 and $11.11, respectively. For the entire sample, the average per capita spending was $14.31. Comparing percentage change in per capita Powerball ticket sales between the first and the winning drawing, we found that the state of Washington had the largest percentage increase at 10,521% followed by California and Texas at 8,826% and 8,085%, respectively. The state of Rhode Island had the smallest percentage increase at 2,188% followed by Nebraska and West Virginia at 2,583% and 2,597%, respectively. For the entire sample, the average percentage change increased by 4,667%.

Table 2 provides correlation coefficients between per capita ticket sales from the 1st to the 20th drawing. Based on the results presented in Table 2, we make the following three observations. First, per capita sales are highly correlated from the 1st to the 17th drawing. The average correlation between the first and next sixteen drawings is 0.93. Second, the correlation between the 1st and the 18th drawing declines to 0.61. The correlation is still high but much lower than correlations from the 1st to the 17th drawing. Third, the correlation between the 1st and the 20th (winning) drawing declines to 0.35. In fact, correlations between the 20th drawing and earlier drawings remain low at less than 0.41 until the 18th drawing. For example, the correlation coefficient between the 17th and the 20th drawing is 0.37. However, the correlation coefficient between the 18th and the 20th drawing increases to 0.49 and the correlation coefficient between the 19th and the 20th drawing jumps to 0.84. Thus, when there were no winners after the 17th drawing and the jackpot
prize approaching $500 million, a significant change in the demand for Powerball tickets appears to take place. As stated earlier, 78.2% of total tickets sold from the 1st to the 20th drawing took place during the last three drawings. These correlation coefficients suggest that the purchasing behavior of consumers during the last three drawings are different from that of earlier drawings.

[Insert Table 2]

IV. Data and Methodology

A. Data


Garrett and Kolesnikova (2015) study illustrates the importance of incorporating local cost of living in empirical models of the demand for state lotteries. In their study, they found the magnitude of income elasticity estimates is larger when local cost of living is included in their models. This study uses state-level lottery sales and income data to estimate state-level income elasticity. According to the regional price parities (RPPs) developed by the U.S. Bureau of Economic Analysis, the regional (state and jurisdiction) price levels ranged from 86.2 to 118.8 in 2015.7 For our sample, the District of Columbia had the highest RPPs at 117.0, followed by New York and New Jersey at 115.3 and 113.4, respectively. On the other hand, Arkansas, South Dakota and Kentucky had the lowest RPPs at 87.4, 88.2, and 88.6, respectively. Since the cost of living varied significantly across state and jurisdiction, we must account for it. To account for the difference in purchasing power across states, we calculate real lottery sales and real income by dividing nominal lottery sales and income data by RPPs.

Before we proceed further, we would like to discuss several limitations that our data is subject to. First, as mentioned above, we are using state-level data to estimate state-level income elasticity. Thus, our results measure responsiveness across states rather than across individuals. Second, this study is based on one
winning drawing. Hence, one must use caution in generalizing our results. Lastly, we assume that state demographics are analogous to purchaser demographics. That is, we assume no substantial across-state migration for ticket purchases. During the sample period, the following six states did not offer the Powerball game to their residents: Alabama, Alaska, Hawaii, Mississippi, Nevada, and Utah. Ten states included in our sample have a border with one of these six states. In addition, the states of Idaho and Tennessee border two non-Powerball states. In the empirical results, we will conduct an analysis on the significance of cross-state border purchases throughout the rollover sequence.

B. Methodology

To estimate lottery regressivity throughout the rollover sequence, for each drawing we ran a regression between real per capita lottery sales and real per capita income for the state and jurisdiction. In addition to the real per capita 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. We also included an indicator variable for whether the state or jurisdiction has commercial casinos. This variable is included to capture any effects of competition between state sponsored lottery and commercial casinos. According to the 2016 State of the States published by the American Gambling Association, there are 24 states in the U.S. with commercial casinos and all of them are included in our sample.

To estimate lottery regressivity for each drawing and for total lottery sales from the 1st to the winning drawing, the following equation is estimated:

\[
\ln \left( \frac{PCS\text{ALE}_{ij}}{RPPS_i} \right) = \alpha_0 + \beta_1 \ln \left( \frac{PC\text{INC}_{ij}}{RPPS_i} \right) + \beta_2 (RACE_i) + \beta_3 (EDUCATION_i) + \beta_4 (CASINO DV_i) + \varepsilon_i \quad (1)
\]

where

- \( \ln \left( \frac{PCS\text{ALE}_{ij}}{RPPS_i} \right) \) is the natural logarithm of real per capita lottery sales in the jth drawing for the ith state or jurisdiction
- \( RPPS_i \) is the regional price parities for the ith state or jurisdiction

i (state or jurisdiction) = 1, 2, ..., 45

j (drawing sequence) = 1, 2, ..., 19, 20, and total sales
\( \ln \left( \frac{PCINC}{RPPS} \right)_i \) is the natural logarithm of real per capita income for the \( i \)th state or jurisdiction

RACE is the total population of white persons as a percentage of the total population in the \( i \)th state or jurisdiction

EDUCATION is the number of people with a high school degree as a percentage of the total population 25 years and over in the \( i \)th state or jurisdiction

CASINODV is a commercial casino indicator variable and takes a value of 1 if the state or jurisdiction has commercial casinos and 0, otherwise

\( \varepsilon \) is the error term

**Empirical Results**

We ran equation (1) for each drawing and for total per capita Powerball lottery sales from November 7, 2015 to January 13, 2016. Table 3 presents results for total per capita sales and 16th through and 20th drawings. Among the control variables, the estimated coefficients for RACE variable are negative and statistically significant at the 5% for the last three drawings. In the last three drawings, as the percentage of white persons in a state or jurisdiction increases, the demand for Powerball tickets declines by a significant amount. The estimated coefficients for EDUCATION variable are positive and statistically significant at the 5% level at the 18th and 19th drawings. As the percentage of the population with a high school degree in a state or jurisdiction increases, the demand for Powerball tickets during the 18th and 19th drawings increase by a significant amount. The estimated coefficients for CASINO indicator variable are positive, except at the 20th drawing, and statistically significant at the 10% level during the 16th through 18th drawings. According to our results, states with commercial casino operations experienced greater lottery sales during the 16th through 18th drawings. For this winning drawing, it appears that state-sponsored lottery gambling did not compete with commercial casinos.

[Insert Table 3]

Table 3 also presents estimated income elasticity results for total per capita sales and for the 16th through 20th drawings. Since sales and income variables are in real terms and measured in logarithms, the estimated regression coefficients are real income elasticity coefficients and reflect how Powerball ticket sales respond to changes in real income at each drawing and for total per capita sales. The estimated coefficient for total
per capita sales is 0.654 and is statistically significant at the 1% level. Thus, during the entire period from November 7, 2015 to January 13, 2016, the Powerball game is regressive. However, examination of the estimated income elasticities from the 16th through 20th drawings reveals changing income elasticity during the last five drawings. The estimated income elasticity coefficient for Draw 16 is 0.546 and is not statistically significant. The estimated coefficient for Draw 17 increases to 0.643 but is not statistically significant. The estimated coefficient for 18th drawing increases to 0.900 and is statistically significant at the 1% level. On the 19th drawing, the estimated coefficient declines sharply to 0.554 and is statistically significant at the 1% level. On the 20th drawing, the estimated coefficient increases to 0.649 and is statistically significant at the 1% level.

According to the results presented in Table 3, the Powerball game remained regressive during the entire rollover sequence from the first drawing on November 7, 2015 to the winning drawing on January 13, 2016. However, the estimated income elasticity did change with jackpot levels but it changed in ways not anticipated by earlier studies. On the 18th drawing with an advertised jackpot of $524.1 million, the estimated income elasticity increased sharply from 0.643 to 0.900. However, on the next drawing with an advertised jackpot of $949.8 million, the estimated income elasticity experienced a significant decline to 0.554. Earlier studies expected lottery regressivity to decline with increasing jackpot levels. For example, Oster (2004) made a cautious out-of-sample prediction that at a jackpot of $806 million, the Powerball lottery will become progressive. According to our results, however, as the jackpot level exceeded $806 million, the Powerball lottery went from being close to progressive to more regressive.

Results presented in Tables 2 and 3 suggest that the purchasing behavior of consumers may have changed during the last three drawings. As was noted earlier, 11.01%, 27.48% and 39.69% of total tickets sold from the 1st to the 20th drawing took place during the 18th, 19th, and 20th drawings, respectively. These sales figures and our results may suggest that the demographics of consumers in the last three drawings are somewhat different than the demographics of earlier drawings. In the next section, we will investigate two potential changes in consumer demographics. First, the participation rate by ethnic groups may have changed as the jackpot prize exceeded $500 million. Second, as the Powerball continued to rollover and
the jackpot prize exceeded $500 million, a significantly larger number of residents from non-Powerball
states may have crossed over to states with the Powerball game to purchase those tickets.

1. Race and Powerball sales

Panel A in Table 4 presents estimated coefficients for the race variables. The WHITE variable
represents the percentage of the white population in the state or jurisdiction while the MINORITY variable
represents the percentage of the black and Hispanic population in the state or jurisdiction. For the 16th and
17th drawings, the estimated coefficients for both variables are statistically insignificant. However, in the
last three drawings, the estimated coefficients for both variables are statistically significant at the 5% level
but with opposite signs. For the WHITE variable, it is negative while for the MINORITY variable it is
positive. That is, during the 18th, 19th, and the 20th drawings, states and jurisdictions with a larger percentage
of whites in the population experienced a statistically significant decline in the demand for Powerball
tickets. On the other hand, states and jurisdictions with a larger percentage of blacks and Hispanics in the
population experienced a statistically significant increase in the demand for Powerball tickets.

[Insert Table 4]

In Table 3, we saw the estimated income elasticity rise sharply on the 18th drawing from the previous
drawing and decline sharply on the 19th drawing. It remained at a lower level on the 20th drawing. From
Panel A in Table 4, we observed that states and jurisdictions with a larger percentage of blacks and
Hispanics experienced a significant increase in the demand for Powerball tickets during the last three
drawings. According to the U.S. Census Bureau, Current Population Survey, 2016 Annual Social and
Economic Supplements, the median household income (in 2015 dollars) in 2015 for blacks, Hispanics, and
whites were $37,211, $45,148 and $60,109, respectively. Combining income data with the results presented
in Panel A in Table 4, we may be able to provide an explanation for the Powerball game’s regressivity
behavior during the last three drawings. As the jackpot prize exceeded $500 million on the 18th drawing
and continued to grow in the next two drawings, the demand for Powerball from households with a lower
household income increased by a significant amount while the demand from households with a higher
household income declined by a significant amount. Thus, it appears that the greater demand from
households with a lower income and a lower demand from households with a higher income may have led
the Powerball game regressivity to decline sharply on the 19th drawing and remain at a lower level on the
20th drawing.

2. Cross-state border purchase

During the sample period, there were six states with no Powerball games available to their residents. Earlier studies such Ghent and Grant (2010) and Han, et. al. (2017) have shown that residents from non-lottery states cross over to neighboring states to purchase lottery tickets. In our sample, there were 10 states with Powerball games that bordered at least one of these six non-Powerball states. To investigate the significance of a cross-state border effect, we added a state-border indicator variable, SBORDER, to equation (1) and re-estimated entire results. The SBORDER variable takes a value of 1 if a state or jurisdiction borders at least one of the six non-Powerball state and 0, otherwise. Results are presented in Panel B in Table 4.

According to results presented in Panel B in Table 4, the estimated coefficients for the SBORDER variable for 16th through 18th drawings are all statistically insignificant. However, on the 19th drawing with the jackpot approaching $1 billion, the estimated coefficient is positive and statistically significant at the 10% level. On the 20th drawing with an advertised jackpot prize of $1.5 billion, the estimated coefficient is 0.163 and is statistically significant at the 1% level. Thus, when there was no winner on the 18th drawing with an advertised jackpot prize of $524.1 million, it appears that significant cross-state border purchases took place to participate in the 19th drawing. When there was no winner on the 19th drawing, an even greater degree of cross-border purchases took place to participate in the world’s largest jackpot prize in history.

SUMMARY AND CONCLUSION

On January 13, 2016, after nineteen rollovers, three lucky winners claimed the world’s largest jackpot prize of $1.5684 billion. This was the first and the only time in U.S. lottery history that the jackpot prize exceeded $1 billion. In pursuit of this grand prize, consumers spent in total $3.385 billion in Powerball tickets from November 7, 2015 to January 13, 2016. Consumers spent $2.646 billion out of $3.385 billion (78.18%) during the last three drawings. This significant increase in ticket sales raises the possibility that
the purchasing behavior of consumers may have changed during the last three drawings which in turn lead
to changes in the Powerball game’s regressivity. In this paper, we examined the Powerball’s regressivity
from the 16th drawing with an advertised jackpot of $301.8 million to the 20th drawing with an advertised
jackpot of $1.5 billion. The last five drawings allowed us to examine if the regressivity continues to decline
and turn progressive as jackpot levels approach the billion-dollar mark. In addition, we also examined the
significance of cross-state border purchases throughout the rollover sequence.

Across the forty-four states and District of Columbia, for the 16th through 18th drawings, there is a
positive relationship between jackpot prize and estimated income elasticity. As the jackpot size increased
from $301.8 million on the 16th drawing to $524.1 million on the 18th drawing, the estimated income
elasticity grew from 0.546 to 0.900. These results are consistent with earlier findings. However, on the
19th drawing with a jackpot size of $949.8 million, the estimated income elasticity declined to 0.554. On
the 20th drawing, the estimated income elasticity increased to 0.649 but remained far below 0.900 reached
on the 18th drawing. According to our results, the Powerball’s regressivity declines with increasing jackpot
levels but up to a point. As the jackpot level approaches the billion-dollar mark, the Powerball’s regressivity
increases by a noticeable amount instead of continuous decline. These findings do not lend support to
Oster’s (2004) cautious out-of-sample prediction that at a jackpot level of $806 million, the Powerball
lottery will become progressive.

During the last three drawings, our results revealed that states and jurisdictions with a larger percentage
of whites in the population experienced a statistically significant decline in the demand for Powerball
tickets. On the other hand, states and jurisdictions with a larger percentage of blacks and Hispanics in the
population experienced a statistically significant increase in the demand for Powerball tickets. Given that
blacks and Hispanics had much lower household incomes compared to whites in 2015, we conjecture that
during the last three drawings, the demand for the Powerball from households with a higher income declined
by a significant amount while the demand from households with a lower income increased by a significant
amount. The greater demand from households with a lower income and a lower demand from households
with a higher income may have led the Powerball’s regressivity to becoming more regressive during the last two drawings.

It appears that during the sample period, a significant amount of money crossed state borders from non-Powerball states to states with the Powerball game. However, according to our results, it was not until the 19th drawing with a jackpot prize approaching $1 billion when statistically significant cross-state border purchases took place. On the 20th drawing, it appears that residents from non-Powerball states spent an even greater amount on Powerball tickets.

Oster (2004) cautiously suggests that a way to address concern about lottery regressivity is to offer lotteries with longer odds and higher jackpots. Her suggestion seems appropriate as long as the jackpot prize does not reach a level where households with lower incomes are enticed to purchase more lottery tickets. For the world’s largest winning drawing, when the jackpot level approached $500 million, the demand for the Powerball game from households with a lower income increased by a significant amount. While the current study provides insight into lottery regressivity at the state and jurisdiction levels, future studies focusing on store- or zip-code level data may provide a more detailed analysis on the relationship between lottery regressivity and jackpot size.
1. State tax on lottery prizes ranges from zero to 8.82% in New York. Currently, eight states and Puerto Rico have no state tax on lottery prizes.

2. January 13, 2016 winning drawing had 26,110,646 winners for the total prize amount of $1.852 billion.

3. Among states and jurisdictions with government-sponsored lottery, California is the only state without the Power Play.

4. Total ticket sales for state of California and Florida include cross-state border purchases by residents from Nevada and Alabama, respectively.

5. Puerto Rico and Virgin Islands are not included in the study due to incomplete socio-demographic data.

6. State lottery allows a player to purchase Powerball tickets for future drawings (Advance Play). In some states, the entire amount will be included in the retailer’s sales for the current drawing only and will not be included in the retailer’s sales for the rest of the month. In others, only the actual amount spent for that drawing will be included. Hence, the sales amount recorded for a drawing may not equal to the actual amount spent on that drawing. However, based on a conversation with a lottery authority it appears that Advance Play is a small fraction of total lottery sales.

7. According to the U.S. Bureau of Economic Analysis, “regional price parities are regional price levels expressed as a percentage of the overall national price level for a given year. This price level is determined by the average prices paid by consumers for the mix of goods and services consumed in each region.” The RPPs for the U.S. is the average price level across all states and the District of Columbia and is set at 100.

8. Correlations among independent variables ranged from -0.388 to 0.553. The highest correlation is between real per capita income and RACE at 0.553 followed by correlation between real per capita income and EDUCATION at -0.388. The rest of the correlations are available upon request.

9. Results for the rest of drawings are available upon request.

10. District of Columbia does not have commercial casinos operating in its jurisdiction.

11. Results for WHITE variable is reproduced from Table 3. For MINORITY variable, we replaced WHITE variable with MINORITY variable in equation (1) and re-estimated the model. Full results are available upon request.
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www.LottoReport.com
Table 1 Draw-by-draw analysis of the January 13, 2016 $1.5864 billion jackpot winning drawing, the largest jackpot prize in U.S. state-sponsored lottery history.

<table>
<thead>
<tr>
<th>Drawing date</th>
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<th>Jackpot level</th>
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<td>$26,447,656</td>
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<td>2&lt;sup&gt;nd&lt;/sup&gt;</td>
<td>$50,000,000</td>
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<td>0.68%</td>
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<td>$70,000,000</td>
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<td>$27,700,594</td>
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</tr>
<tr>
<td>11/25</td>
<td>6&lt;sup&gt;th&lt;/sup&gt;</td>
<td>$90,000,000</td>
<td>$28,689,389</td>
<td>0.85%</td>
</tr>
<tr>
<td>11/28</td>
<td>7&lt;sup&gt;th&lt;/sup&gt;</td>
<td>$100,000,000</td>
<td>$29,661,675</td>
<td>0.88%</td>
</tr>
<tr>
<td>12/2</td>
<td>8&lt;sup&gt;th&lt;/sup&gt;</td>
<td>$110,000,000</td>
<td>$31,470,249</td>
<td>0.93%</td>
</tr>
<tr>
<td>12/5</td>
<td>9&lt;sup&gt;th&lt;/sup&gt;</td>
<td>$127,000,000</td>
<td>$35,771,805</td>
<td>1.06%</td>
</tr>
<tr>
<td>12/9</td>
<td>10&lt;sup&gt;th&lt;/sup&gt;</td>
<td>$145,000,000</td>
<td>$35,545,427</td>
<td>1.05%</td>
</tr>
<tr>
<td>12/12</td>
<td>11&lt;sup&gt;th&lt;/sup&gt;</td>
<td>$164,000,000</td>
<td>$39,978,723</td>
<td>1.18%</td>
</tr>
<tr>
<td>12/16</td>
<td>12&lt;sup&gt;th&lt;/sup&gt;</td>
<td>$180,000,000</td>
<td>$40,148,819</td>
<td>1.19%</td>
</tr>
<tr>
<td>12/19</td>
<td>13&lt;sup&gt;th&lt;/sup&gt;</td>
<td>$202,000,000</td>
<td>$50,720,851</td>
<td>1.50%</td>
</tr>
<tr>
<td>12/23</td>
<td>14&lt;sup&gt;th&lt;/sup&gt;</td>
<td>$227,000,000</td>
<td>$58,563,224</td>
<td>1.73%</td>
</tr>
<tr>
<td>12/26</td>
<td>15&lt;sup&gt;th&lt;/sup&gt;</td>
<td>$255,000,000</td>
<td>$56,269,447</td>
<td>1.66%</td>
</tr>
<tr>
<td>12/30</td>
<td>16&lt;sup&gt;th&lt;/sup&gt;</td>
<td>$301,800,000</td>
<td>$87,618,049</td>
<td>2.59%</td>
</tr>
<tr>
<td>1/2/2016</td>
<td>17&lt;sup&gt;th&lt;/sup&gt;</td>
<td>$355,800,000</td>
<td>$115,805,200</td>
<td>3.42%</td>
</tr>
<tr>
<td>1/6</td>
<td>18&lt;sup&gt;th&lt;/sup&gt;</td>
<td>$524,100,000</td>
<td>$372,637,148</td>
<td>11.01%</td>
</tr>
<tr>
<td>1/9</td>
<td>19&lt;sup&gt;th&lt;/sup&gt;</td>
<td>$949,800,000</td>
<td>$929,998,415</td>
<td>27.48%</td>
</tr>
<tr>
<td>1/13</td>
<td>20&lt;sup&gt;th&lt;/sup&gt;</td>
<td>$1,586,400,000</td>
<td>$1,343,334,683</td>
<td>39.69%</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Total sales</strong></td>
<td><strong>$3,384,591,752</strong></td>
<td></td>
</tr>
</tbody>
</table>

Source: www.LottoReport.com

a. Advertised jackpot was $1.5 billion but the actual jackpot awarded was $1.5864 billion.
Table 2 Correlations coefficients between the 1st and subsequent drawings.

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<tr>
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<th></th>
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<th></th>
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<tbody>
<tr>
<td>Draw 1</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Draw 2</td>
<td>0.992</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Draw 3</td>
<td>0.998</td>
<td>0.994</td>
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<tr>
<td>Draw 4</td>
<td>0.986</td>
<td>0.993</td>
<td></td>
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<tr>
<td>Draw 5</td>
<td>0.991</td>
<td>0.985</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Draw 6</td>
<td>0.977</td>
<td>0.984</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Draw 7</td>
<td>0.973</td>
<td>0.968</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Draw 8</td>
<td>0.960</td>
<td>0.966</td>
<td></td>
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<td></td>
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<tr>
<td>Draw 9</td>
<td>0.968</td>
<td>0.965</td>
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<tr>
<td>Draw 10</td>
<td>0.938</td>
<td>0.946</td>
<td></td>
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<tr>
<td>Draw 11</td>
<td>0.951</td>
<td>0.947</td>
<td>1.000</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Draw 12</td>
<td>0.904</td>
<td>0.905</td>
<td>0.985</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Draw 13</td>
<td>0.890</td>
<td>0.882</td>
<td>0.977</td>
<td>0.984</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Draw 14</td>
<td>0.846</td>
<td>0.846</td>
<td>0.944</td>
<td>0.961</td>
<td>0.985</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Draw 15</td>
<td>0.841</td>
<td>0.827</td>
<td>0.918</td>
<td>0.917</td>
<td>0.959</td>
<td>0.969</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Draw 16</td>
<td>0.713</td>
<td>0.704</td>
<td>0.836</td>
<td>0.873</td>
<td>0.904</td>
<td>0.939</td>
<td>0.901</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Draw 17</td>
<td>0.763</td>
<td>0.746</td>
<td>0.869</td>
<td>0.894</td>
<td>0.927</td>
<td>0.948</td>
<td>0.929</td>
<td>0.962</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Draw 18</td>
<td>0.607</td>
<td>0.588</td>
<td>0.715</td>
<td>0.753</td>
<td>0.757</td>
<td>0.774</td>
<td>0.720</td>
<td>0.833</td>
<td>0.889</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>Draw 19</td>
<td>0.568</td>
<td>0.571</td>
<td>0.632</td>
<td>0.661</td>
<td>0.644</td>
<td>0.649</td>
<td>0.611</td>
<td>0.725</td>
<td>0.717</td>
<td>0.802</td>
<td>1.000</td>
</tr>
<tr>
<td>Draw 20</td>
<td>0.350</td>
<td>0.391</td>
<td>0.364</td>
<td>0.400</td>
<td>0.342</td>
<td>0.356</td>
<td>0.293</td>
<td>0.409</td>
<td>0.368</td>
<td>0.487</td>
<td>0.843</td>
</tr>
</tbody>
</table>
Table 3 Estimated income elasticity. The dependent variable is the natural logarithm of total per capita Powerball lottery sales from November 7, 2015 to January 13, 2016 and per capita Powerball lottery sales at the 16th, 17th, 18th, 19th, and 20th drawings. Standard errors are reported in parentheses (N = 45).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Dependent variable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
</tr>
<tr>
<td>Income</td>
<td>0.654*** (0.244)</td>
</tr>
<tr>
<td>Race</td>
<td>-0.368* (0.204)</td>
</tr>
<tr>
<td>Education</td>
<td>0.012 (0.008)</td>
</tr>
<tr>
<td>Casino</td>
<td>0.042 (0.052)</td>
</tr>
<tr>
<td>Adjusted-R(^2)</td>
<td>0.136</td>
</tr>
<tr>
<td>F-value</td>
<td>2.726</td>
</tr>
<tr>
<td>P(F-statistic)</td>
<td>0.043</td>
</tr>
</tbody>
</table>

*, **, *** significant at the 10%, 5% and 1% levels, respectively.
Table 4 Additional tests. The dependent variable is the natural logarithm of total per capita Powerball lottery sales from November 7, 2015 to January 13, 2016 and per capita Powerball lottery sales at the 16th, 17th, 18th, 19th, and 20th drawings. Standard errors are reported in parentheses (N = 45).

**Panel A: Race and Powerball sales**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total</th>
<th>Draw 16</th>
<th>Draw 17</th>
<th>Draw 18</th>
<th>Draw 19</th>
<th>Draw 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>White*</td>
<td>-0.368* (0.204)</td>
<td>-0.142 (0.404)</td>
<td>-0.109 (0.365)</td>
<td>-0.579** (0.253)</td>
<td>-0.529*** (0.180)</td>
<td>-0.480** (0.199)</td>
</tr>
<tr>
<td>Minorityb</td>
<td>0.427** (0.206)</td>
<td>0.265 (0.411)</td>
<td>0.249 (0.372)</td>
<td>0.681*** (0.253)</td>
<td>0.578*** (0.181)</td>
<td>0.478** (0.204)</td>
</tr>
</tbody>
</table>

**Panel B: Cross-state border purchases**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total</th>
<th>Draw 16</th>
<th>Draw 17</th>
<th>Draw 18</th>
<th>Draw 19</th>
<th>Draw 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBORDERc</td>
<td>0.083 (0.063)</td>
<td>-0.028 (0.127)</td>
<td>-0.071 (0.115)</td>
<td>-0.090 (0.079)</td>
<td>0.095* (0.055)</td>
<td>0.163*** (0.057)</td>
</tr>
</tbody>
</table>

*, **, *** significant at the 10%, 5% and 1% levels, respectively.

- a. Reproduced from Table 3.
- b. We replaced WHITE variable with MINORITY (refers to blacks or Hispanics) variable in equation (1) and re-estimated the model. Estimation results for the rest of independent variables are available upon request.
- c. SBORDER variable is a state-border indicator variable and takes a value of 1 if a state or jurisdiction borders at least one of the six non-Powerball states and 0, otherwise. We added this variable to equation (1) and re-estimated the model. Full estimation results are available upon request.