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The Effects of Lottery Promotions, Credit Constraints, and the Stock Market on Daily New Jersey Lottery Sales

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Abstract:

This paper estimates the price elasticity of demand for daily Pick 3 and Pick 4 lottery games using random price variation generated by the New Jersey Lottery's evening Pick 3 Green Ball promotion and Pick 4 Red Ball promotion. These promotions lower the price of a lottery ticket for an evening daily numbers game by increasing prize payments during the promotion period. The own-price elasticity of demand for evening Pick 3 is -0.50, while the own-price elasticity of demand for evening Pick 4 is -0.57. This inelastic demand implies that the loss in margin outweighs the gain in sales during the promotion for the promoted lottery game. Midday Pick 3 and Pick 4 lottery sales increase because of the price promotions for their evening counterparts. The lottery promotions also moderately increase midday daily game sales and Pick 3 and Pick 4 sales temporarily after the promotions end. Our findings that sales are significantly higher on Fridays and at the start of a month are consistent with daily lottery players facing credit constraints.

1. Introduction

Factors that drive the sales of lottery tickets are fundamental in informing governments as they attempt increase net lottery revenue.[1] One key variable that drives sales is the implicit price of a lottery ticket, or the expected loss to a lottery consumer. This should make knowledge of price elasticities an important part of state lotteries' revenue maximization plan. Interestingly, however, these elasticities have been understudied because the variation in the prices of lottery tickets has been difficult to capture and then subsequently analyze. That is, the face value of lottery tickets tends to remain largely stable for prospective players. In addressing this identification challenge, economists have used multiple means of determining price effects, such as studying changes in lottery design features over long periods of time or exploiting differences in the operational management of games that run across lottery jurisdictions (Beenstock, Goldin, and Haitovsky 2000; DeBoer 1986; Vrooman 1976). The central problem with some of these studies, however, is that the design changes might be endogenous to the games themselves, such as when policymakers institute rule modifications due to flagging sales.

By far the most promising source of price variation that has been utilized by economists to specify these elasticities without the confounding bias of potential endogeneity has been the use of lottery jackpot rollovers (Cook and Clotfelter 1993; Gulley and Scott 1993). Briefly stated, in some lottery pari-mutuel games, when there are no winners, the jackpot is "rolled over" into the next day's winnings. Far from being uncommon in lottery games, rollovers actually happen quite frequently due to what Cook and Clotfelter call the "conscious selection" of potential winning numbers by players. The conscious selection of numbers means that individuals do not select winning numbers according to a uniform probability distribution; rather, certain numbers are consistently chosen over other numbers, and this nonuniformity increases the likelihood that rollovers will take place. Beyond the regularity of rollover occurrences, most important for the discussion here is that these jackpot turnovers produce an effect similar to an exogeneous change in lottery ticket prices. This is because rollovers generate a change in the expected value of tickets—defined as the price of the ticket minus the expected winnings.

Rollovers thus provide the variation of price necessary to estimate the price elasticity of demand for lottery tickets in many contexts. For example, United Kingdom residents can play the National Lottery, a game in which individuals must match 6 numbers drawn from 49 numbers without replacement (also known as a 6/49 game) in order to win a jackpot of millions of pounds. In one analysis, Farrell, Morgenroth, and Walker (1999) use aggregate sales data from the United Kingdom's weekly drawings over the period November 1994- February 1997, and report elasticities ranging from -1.04 to -1.55, depending on the length of time considered. In a later study on the same lottery, Farrell et al. (2000) find the price elasticities over a slightly different time period, from November 1994- February 1996, to be between -.80 to -1.06. Forrest

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[1] Lottery dynamics beyond the sales question have received much attention by economists, such as analyses that explore the income distribution of lottery players (Blalock, Just, and Simon 2007; Clotfelter and Cook 1989; Combs, Kim, and Spry 2008; Haisley, Mostafa, and Lowenstein 2008); whether the presence of such games leads to higher government expenditures overall in specified budgetary cycles (Whitaker 2007); and why anyone chooses to purchase such tickets in the face of overwhelmingly low odds of ever winning any prize money (Bhattacharya and Garrett 2008; Downs and Wen 2001; Yu 2008).

et al. (2000) also study the same lottery from November 1994-October 1997, using both rollovers and superdraws—episodic infusions of funds into the lottery to mark special occasions—to induce price variation and find the price elasticity to be -1.03. Providing more evidence from this context, Farrell and Walker (1999), using individual instead of aggregate data from approximately five surveys of 1800 United Kingdom National Lottery players each over the period 1994-1996, report price elasticities of between -1.456 to -1.785 depending on the model specification. Finally, studies focusing on other pari-mutuel lotteries with rollovers such as in Canada and Israel have discovered price elasticities ranging from -.65 to -.672 (Beenstock and Haitovsky 2001; Yu 2008).

This analysis introduces another innovative way to explore price variation based on daily lottery ticket sales of the New Jersey Pick 3 and Pick 4 games. These games at times have a special design feature called the "bonus ball" promotions—the Green Ball Double Draw for Pick 3 and the Red Ball Double Up for Pick 4—that result in players reaping larger than normal winnings. More specifically, the Pick 3 Green Ball Double Draw promotion pays prizes based on two sets of winning numbers when a green ball is drawn in a secondary drawing. Similarly, the Pick 4 Red Ball Double Up promotion doubles prize payments when a red ball is drawn in a secondary drawing. In effect, these promotions lower the price of a lottery ticket for an evening daily numbers game by increasing prize payments during the promotion period. Other states, such as Ohio, Tennessee, Illinois, and Pennsylvania, have similar "bonus ball" promotions, but with different odds and prize packages.[2] In the current analysis, we estimate the price elasticities of demand for Pick 3 and Pick 4 lottery games in New Jersey using the random price changes created by these promotions. This estimation strategy also allows us to determine the effects of these promotions on sales for these games, which can have decisive impacts New Jersey Lottery revenue and state profits overall.

There are, of course, other factors beyond price that can impact the sale of lottery tickets. The first such influence involves competing lottery products. Lin and Lai (2006), for example, employed data from all of the 104 draws in 2004 for the Big Lotto (a 6/49 game) and the regular Lotto (a 6/42 game) in Taiwan and find no significant substitutive or complementary relationships between single draws of these games. On the other hand, several other studies have demonstrated strong substitutive effects between games. For instance, Thalheimer and Ali (2003) report table gaming to be substitutes for slot machines, and Thalheimer (2008), using data from July 1994-December 2002 in West Virginia at racinos—where video game lotteries (VLTs) and racetracks are under one roof—show that relaxing restrictions on video lottery terminals decreased the demand for pari-mutuel wagering on races at the same facility.

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[2] For example, the Ohio Lottery has used a Red Ball promotion for its Pick 3 game that starts with six white balls and one red ball. In contrast to the New Jersey Lottery, the Ohio promotion is less generous to players as prizes are increased only 20% when the Red Ball is drawn. The Tennessee Lottery has used a Green Ball promotion for its Cash 3 game that starts with ten white balls and one green ball. Tennessee increases Cash 3 prizes 20% when its Pick 3 green ball is drawn. The Pennsylvania Lottery has run a "Shamrock Bonus Week" during the week including St. Patrick's Day in which evening daily numbers games prizes are increased 10% if a green ball is drawn or 20% if a shamrock ball is drawn. Finally, the Illinois Lottery has operated Green Ball promotions for its Pick 3 game where two sets of winning numbers are drawn when a green ball is selected. These Illinois promotions start with 9 white balls and one green ball.

A second potential influence not previously examined relates to the competition afforded by the ability to participate in the stock market. Kumar (Forthcoming) studied the socio-economic factors that lead individuals to "gamble in the stock market" by investing in stocks that are similar to lottery games. These are stocks that offer a high chance of a small loss and low chance of a large gain. Kumar finds that at the aggregate level, individuals tend to be attracted to stocks with lottery attributes, and that just like lottery demand, this type of stock demand increases during economic downturns. More generally, however, research has yet to address whether lottery sales and the stock market are unrelated, complements, or substitutes.

A third potential factor that may influence lottery sales involves credit constraints. Credit constraints are a market imperfection that occurs when the consumption decisions of individuals are limited by borrowing limits. Consumers with ready access to credit can use their liquidity to smooth the timing of consumption. Conversely, credit constrained consumers may be constrained to limit their purchases before the arrival of income (Attanasio, Goldberg, and Kyriazidou 2008).

Credit constrained lottery players may be unable to play until they receive a paycheck on Friday. In addition, credit constraints may also affect consumers on a monthly basis. If consumers are waiting for a check to arrive on the first of the month and are credit constrained, then we would expect sales to be higher at the beginning of the month and lower at the end of the month. The previous literature on lottery sales has not tested for evidence of credit constraints. This omission is probably due to the widespread use of annual or monthly data in this literature which can not be used to examine higher frequency patterns of sales. Our high frequency daily Pick 3 and Pick 4 sales (which consist of both midday and evening draws) provide an ideal dataset for testing for the effects of credit constraints on the sales of daily numbers games. In addition, empirical evidence about credit constraints is especially important in informing the literature on the permanent income hypothesis (Friedman 1957) and Ricardian Equivalence (Barro 1974). That is, the permanent income hypothesis and Ricardian Equivalence may or may not strictly hold in the presence of credit constraints.

A fourth potential factor affecting lottery sales involves how much planning individuals do when there is a planned interruption in lottery product availability. Do individuals "stock up" on tickets in such circumstances? If so, this would indicate that lottery players have a longer-term spending plan. A governmental shutdown in New Jersey, which temporarily prevented individuals from buying tickets, as well as regularly scheduled holidays, enable us to study this dynamic.

2. The New Jersey Pick 3 and Pick 4 Games and Related Green Ball and Red Ball Promotions

The New Jersey Lottery sells a variety of lottery products. During the fiscal year 2007[3], the Pick 3 daily numbers game was the second highest selling lottery game and the Pick 4 daily numbers was the third highest selling lottery game, as shown in Table 1. The New Jersey Pick 3 and Pick 4 games are similar to the illegal numbers games that operated before the creation of the New

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[3] The New Jersey fiscal year runs from July 1 to June 30 of the following year.

Jersey Lottery in 1970. These games offer smaller prizes and higher odds of winning the top prize than lotto games like the well-known Mega-Millions and Powerball games.

In the regular Pick 3 New Jersey lottery game, players place bets on the outcome of three independent drawings of numbers ranging from 0 to 9. In a Pick 3 "straight" bet, players have a 1 in 1,000 chance of matching all three winning numbers in exact order. Players can also place box bets, that their three numbers will be selected in any order, or simply whether just a pair of numbers will appear in the drawing.

In a typical Pick 3 drawing, "fifty percent of the total amount of all bets for each game [is to] be placed in the game's prize pool to be shared by the winners in accordance with a pari-mutuel formula."[4] New Jersey and Massachusetts are the only two states with pari-mutuel payouts for their daily numbers games. The Pick 3 and Pick 4 in New Jersey are pari-mutual games so that the exact prizes paid depend on the number of bets placed on the winning numbers. The total amount of prize money is fixed and split among all winning tickets.[5] Thus in New Jersey bets on popular numbers, like 7-7-7 or the date of the drawing have a much lower expected value than bets on less popular numbers because the odds of winning are the same for all number but the payouts are higher for numbers that are played by fewer other lottery players.

The New Jersey Lottery runs two drawings per day of the Pick 3 game, a midday drawing at 12:29 p.m. and an evening drawing at 7:29 p.m. The Pick 4 game operates in the same way as the Pick 3 game, except with four independent drawings of numbers ranging in value from 0 to 9 instead of three. A straight Pick 4 bet has a 1 in 10,000 chance of selecting all four numbers in order. There are also Pick 4 bets that can be placed to match the numbers drawn regardless of the order in which the numbers are drawn.

The New Jersey Lottery operates special promotions called the Green Ball Double Draw and the Red Ball Double Up, respectively. The Green Ball Double Draw promotion increases the expected value of an evening Pick 3 bet by drawing two sets of winning numbers instead of just one. This increase in expected value reduces the implicit lottery tax and the effective price of gambling. The Green Ball promotion only takes place during the evening drawing, when it starts with either 5 or 6 white balls[6] and one green ball in a hopper.

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[4] Source: http://www.state.nj.us/lottery/index.shtml The New Jersey Lottery pays out a higher percentage of money bet on straight bets than on other bets. Terrell (1994) reports that for straight bets in the Pick 3 game the New Jersey Lottery "places 52% of all money bet in the game into the payout pool to be split equally among all bettors choosing the correct number."

[5] When the number 5-8-7 were draw the evening of November 12, 2001 after American Airlines Flight 587 crashed earlier that day the winning 50 cent straight bet of the tragic numbers 5-8-7 paid only $16, the smallest payment in the history of the New Jersey Lottery Pick 3 game, because 27,829 straight bets were placed on that number. The previous time 5-8-7 were the winning numbers the prize for a straight $0.50 bet was $290.50. When 7-7-7 was drawn on December 21, 1988 the winning prize for a straight $0.50 bet was only $63.50.

[6] During some Green Ball promotions the New Jersey Lottery designed the promotion to start with 5 white balls and in other years the Green Ball promotion begins with 6 white balls. The promotion is more generous when it begins with a smaller number of white balls. This increases the odds of prize payments during the promotion period. The first Green Ball promotion in our sample ran from March 7, 2005 until March 29, 2005 with 5 white balls and one green ball. The rest of the Green Ball promotions were run with 6 white balls and one green ball from February 6, 2006 until March 5, 2006, February 19, 2007 until March 18, 2007, March 3 until March 30, 2008 and March 2, 2009 until March 29, 2009.

If the green ball is selected, then two sets of winning Pick 3 numbers are drawn. In contrast, if a white ball is chosen, then that white ball is removed before the next evening's Green Ball drawing. Thus expected value of the evening Pick 3 drawing varies during the Green Ball promotion. Ultimately, if only the green ball is left, that evening's odds of winning are approximately doubled, since two sets of winning number are drawn. After a green ball is drawn, the promotional hopper is reset with the initial number of white balls and one green ball.

The Red Ball Double Up promotion increases the expected value of an evening Pick 4 bet by doubling the prize paid when the red ball is drawn during the promotion. This increase in expected value reduces the implicit lottery tax and the effective price of placing a gamble. The Red Ball Double Up promotion starts with 6 white balls and one red ball in a hopper.[7] If the red ball is selected during the evening Pick 4 drawing, then all winning prizes are doubled. If, on the other hand, a white ball is drawn, then that white ball is removed before the next evening's Red Ball drawing. When only a red ball remains in the promotional hopper, that evening's prize payments will be doubled since the Red Ball has to be drawn. Again, the expected value of the evening Pick 4 drawing varies during the Red Ball Double Up promotion.

In a regular New Jersey Lottery Pick 3 game, 50% of the total amount bet in that drawing is placed in the pool to be returned to players as pari-mutuel prizes; the New Jersey Lottery keeps the other 50%. Therefore, the expected value of an average regular Pick 3 New Jersey lottery ticket is $0.50 and the cost of purchasing a dollar of expected Pick 3 prize payments is $2.00. It is important to note that since the New Jersey Lottery has decided to run promotions only during the evening drawings, the expected value of a purchase of a $1.00 midday Pick 3 or Pick 4 lottery ticket remains $0.50 at all times.

The Green Ball Double Draw promotion for Pick 3 and the Red Ball Double Up promotion for Pick 4 provide natural experiments that we exploit to estimate the demand for daily lottery games in New Jersey. As described above, it is usually difficult to estimate the demand for a product based on historical data on prices and the quantity or volume of sales because of the identification problem. Fortunately, the random changes in prices for Pick 3 and Pick 4 caused by the promotions identify the demand curve without the need to use more complex econometric methods such as instrumental variables estimation and two stage least squares techniques. The changes in the quantity of Pick 3 lottery tickets sold each day during the promotion are the result of a random change in prices driven by the Green Ball Double Draw events. These changes, in effect, identify the Pick 3 demand curve. The price variation is driven by the number of white balls in the hopper with the green ball.[8]

When there are six white balls and one green ball in the hopper for the Green Ball Double Draw promotion, the expected value of an dollar lottery ticket is $0.5714. Fifty cents is due to the expected value of the normal prize pool being 50% of the Pick 3 sales and the extra $0.0714 is due to the one in seven chance of a Pick 3 Double Draw resulting in prize payments for two sets

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[7] The Red Ball promotion was held October 30, 2006 until November 26, 2006, August 6, 2007 until September 2, 2007, and October 13, 2008 until November 9, 2008.

[8] The New Jersey Lottery has a monopoly in the New Jersey market for lottery tickets. Therefore, there is no supply curve for this market.

of winning numbers. The cost of a dollar of expected Pick 3 prizes is $1.75 when there are six white balls and one green ball during the promotion.

As the number of white balls falls, the odds of winning increase during the Green Ball Double Draw promotion and the price of a Pick 3 lottery ticket declines. This relationship between the number of white balls in the evening Green Ball drawing and the expected value of a ticket and the cost of a dollar of expected winnings is displayed in Table 1.

The expected value of the average Pick 3 lottery ticket is as high as $1.00 during the Green Ball promotion when only the Green Ball is in the secondary drawing for the evening.
The average cost of a $1.00 of expected prize winnings is also $1.00 when there is an one hundred percent change of drawing a Green Ball. Due to the pari-mutual nature of the New Jersey Pick 3 game bets on unpopular numbers will have a positive expected return while bets on popular numbers will still have a negative expected return.

The variation in prices for the Pick 4 lottery similarly occurs during the Red Ball Double Up promotion, and so by extension, all of the above discussion on price changes applies to Pick 4 as well. The combination of the pari-mutual prizes and the Pick 4 Up Double promotion create the possibility that a limited number of bets on unpopular numbers may have a positive expected value. When only the Red Ball is left for an evening drawing, lottery players know that their the prizes for winning Pick 4 bets will be doubled that evening because of the Pick 4 Up Double promotion. Table 2 shows the relationship between the number of white balls in the secondary Red Ball evening drawing and the expected value of a lottery ticket and the cost of a dollar of expected winnings. A small bet on unpopular numbers under these circumstances will have a positive expected value. The pari-mutual nature of the prize payments limits the ability for savvy investors to take advantage of this arbitrage opportunity.

3. Data, Data Exploration and Descriptive Statistics

The New Jersey Lottery provided data on Pick 3 and Pick 4[9] sales for both midday and evening drawings, and the size of the upcoming Mega-Millions jackpot from July 1, 2004 until April 15, 2009. The lottery did not hold drawings for Pick 3 and Pick 4 on Christmas Day and from July 3 to July 7, 2006 because of a New Jersey government shutdown. There are a total of 1740 days of lottery drawings in the sample.

Table 1 shows the average sales for the Pick 3 and Pick 4, evening and midday New Jersey lottery games. Figure 1 shows the relationship between the price of Pick 3 evening tickets, measured as the cost of a dollar of expected prize winnings, and Pick 3 evening sales. The averages are displayed for the entire sample, during and outside of the Green Ball promotion, and by the number of white balls in the secondary drawing. When previous secondary Green Ball evening drawings result in a white ball being drawn, that white ball is removed from the secondary drawing and the odds of a Green Ball being drawn increases for the next drawing as shown in the second column of Table 1.

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[9] Additional Information about New Jersey Pick 3 and Pick 4 games and rules is available at the New Jersey Lottery Website: http://www.state.nj.us/lottery/index.shtml.

Average evening Pick 3 sales increase from $785,896 outside of a Green Ball promotion to $877,136 during the Green Ball promotion. Average evening Pick 3 sales increase during the promotion as number of white balls in the Green Ball secondary drawing decreases. This effect is monotonic, except when comparing drawings with 6 white balls to drawings with 5 white balls, where average sales drop when the odds improve. This anomaly is due to the rules of the Green Ball promotion resetting the number of white balls in the secondary Green Ball drawing for the evening after a Green Ball is drawn and double prizes are paid. The last two rows break the days with six white balls into two categories: days after a Green Ball was drawn and double prizes are awarded and the first day of a promotion that does not follow the drawing a Green Ball. Sales are about $57,000 higher the day after a Green Ball is drawn when there are six white balls in the drawing. This suggests that part of the double prize payments from the Green Ball promotion are used to purchase additional evening Pick 3 lottery tickets for the following evening.

Average sales of Pick 3 midday, Pick 4 evening and Pick 4 midday lottery tickets are all higher during the Green Ball promotion. This is interesting because the Green Ball promotion only applies to the evening Pick 3 drawing. A reduction in midday Pick 3 and Pick 4 sales might have been anticipated because the expected price of Pick 3 evening game falls during the Green Ball promotion. A bettor would only have to wait an additional seven hours for the realization of the outcome of a Pick 3 bet in order to have a chance of two sets of winning Pick 3 numbers being drawn during the Green Ball promotion.

Table 2 shows the average sales for the Pick 3 and Pick 4, evening and midday New Jersey lottery games for the entire sample, during and outside of the Red Ball promotion, and by the number of white balls in the secondary drawing. Figure 1 shows the relationship between the price of Pick 4 evening tickets, measured as the cost of a dollar of expected prize winnings, and Pick 4 evening sales. When previous secondary Red Ball evening drawings result in a white ball being drawn, that white ball is removed from the secondary drawing and the odds of a Red Ball being drawn increases for the next drawing as shown in the second column of Table 2.

Average evening Pick 4 sales increase from $481,193 outside of a Green Ball promotion to $534,231 during the Red Ball promotion. Average evening Pick 3 sales generally increase during the promotion as number of white balls in the Green Ball secondary drawing decreases. The sales of Pick 4 evening lottery tickets are higher the evening after a Red Ball is drawn and prize amounts are doubled. The last two rows break the days with six white balls into two categories: days after a Red Ball was drawn and prizes are doubled and the first day of a promotion that does not follow the drawing a Red Ball. Sales are about $22,000 higher the day after a Green Ball is drawn when there are six white balls in the drawing. This suggests that part of the double prize payments from the Red Ball promotion are used to purchase additional evening Pick 4 lottery tickets for the following evening.
Average sales of Pick 3 midday and Pick 3 evening lottery tickets fall slightly during the Red Ball promotion. Sales of Pick 4 midday lottery tickets increase about $10,000 during the Red Ball promotion. The Red Ball promotion only applies to the evening Pick 4 drawing. This suggests that either betters are very impatient, willing to give up expected value to learn the resolution of the bet seven hours earlier, or some betters do not understand that the promotions only apply to the evening lottery drawings.

Table 3 show descriptive statistics for the entire sample of 1740 days with New Jersey Lottery drawings. In addition to daily midday and evening Pick 3 and Pick 4 sales the dataset includes variables for the cost of bets, and other variables that may influence the demand for Pick 3 and Pick 4 lottery tickets. These variables include the number of white balls during promotions, the expected value of a bet, the expected cost of a dollar of winnings for a Pick 3 and Pick 4 ticket, day of week dummy variables, a dummy variable for the day after a Green Ball is drawn, a dummy variable for the day after a Red Ball is drawn, the pari-mutual payouts for Pick 3 and Pick 4 games, the size of the Mega-Millions jackpot,

Additional variables in the data set include a dummy variable for the two days prior to the 2006 New Jersey government shutdown, dummy variables for the first five days of the month and the last five days of the month, a dummy variable for the first 45 days after the end of the Green Ball Promotion, an inverse trend for the first 45 days after the end of the Green Ball promotion equal to 45 minus the number of days after the Green Ball promotion, a dummy variable for the first 45 days after the end of the Red Ball Promotion, an inverse trend for the first 45 days after the end of the Red Ball promotion equal to 45 minus the number of days after the Red Ball promotion, daily precipitation, monthly unemployment rates, daily Dow Jones Industrial Average price and volume data, and a linear time trend.

Before moving to regression analysis we test for the presence of a unit root in each of our four time series; Pick 3 midday sales, Pick 3 evening sales, Pick 4 midday sales, and Pick 4 evening sales. We want to ensure that our dependent variables are trend-stationary. That is we want to test whether Pick 3 and Pick 4 lottery sales are exploding over time. Time series regression involving dependent variables with unit roots lead to spurious correlations and should be avoided.

We use the augmented Dickey-Fuller test[10] for the presence of a unit root in the level of these four time series. The null hypothesis is that the level of the series has a unit root and the alternative hypothesis is that there is not a unit root. The results of the augmented Dickey-Fuller tests are presented in Table 4. We are able to strongly reject that there is a unit root in the dependent variables. This allows us to proceed to estimate the demand for New Jersey Lottery tickets using multiple regression.

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[10] The augmented Dickey-Fuller unit root test was performed with the standard commands in Eviews 6. We also conducted Philips-Perron tests for a unit root in the level of the same series and also rejected the null hypothesis of a unit root.

4. Demand Estimation and Results

We estimate four separate regressions for the dependent variables of the natural logarithm of sales of Pick 3 in the evening, the natural logarithm of the sales of Pick 4 in the evening, the natural logarithm of the midday sales of Pick 3, and the natural logarithm of midday sales of Pick 4. We use a log-log specification for the price variables so that the coefficients can be interpreted as price elasticities. We use the following variables and specification.

We include the natural logarithm of the game's price for the evening Pick 3 and evening Pick 4 games to exploit the random variation in caused by the Green Ball and Red Ball promotions. The measure of price used is the expected cost of a dollar of expected prize winnings. This measure of price ranges between $2.00 to $1.00 and is well suited to the logarithm transformation used to produce regression coefficients that are elasticities. In the regressions with the evening Pick 3 and Pick 4 sales as the dependent variable these variables allow us to estimate the own-price elasticity of demand and the cross-price elasticity of demand. In the regressions with the midday Pick 3 and Pick 4 sales as the dependent variable these variables estimate only the cross-price elasticities of demand with respect to the price of the evening Pick 3 and evening Pick 4 game respectively, which vary during the promotions. Executives at the New Jersey Lottery should be concerned about the effect of the Pick 3 Green Ball Double Draw Promotion not only on evening Pick 3 sales but also on the sales of other games.

Similarly, the Pick 4 Red Ball Double Up promotion may help Pick 3 sales if these games are complements or hurt Pick 3 sales if these games are substitutes. Therefore we include the Pick 3 price and the Pick 4 price (in logs) in all regression equations. The Green Ball Double Draw Pick 3 and Red Ball Pick 4 Double Up promotions are offered only for evening drawings. Therefore, New Jersey Lottery officials might be concerned that these promotions for the evening drawings may cannibalize sales from the midday drawings. On the other hand, perhaps the excitement from these promotions for the evening drawings spills over into greater sales in the midday drawings for Pick 3 and Pick 4.

The rules of the Pick 3 Green Ball Double Draw and Pick 4 Red Ball Double Up promotions reset the drawings to the original number of white balls (usually six) and colored ball for the next evening drawing after double prizes have been paid. Lottery players may use some of their double prize payments to purchase additional lottery tickets for the following midday or evening drawings. Therefore, we include dummies variable for both the first drawing after Pick 3 Double Draw prizes are paid and for the first drawing after Pick 4 Double Up prizes are paid.

The pari-mutual nature of the Pick 3 and Pick 4 prize payments offers an opportunity to test the effects of the size and type of prize payments on sales for the next day's drawing. When a popular set of numbers is drawn the size of the pari-mutual prizes are smaller, but more lottery players receive winnings. When an unpopular number is drawn fewer prizes are awarded, but each price is larger. We include the size of the prize payments for the previous evening Pick 3 and previous midday Pick 3 in the equations for Pick 3 sales. Similarly, we include size of the prize payments for the previous evening Pick 4 and previous midday Pick 4 in the equations for Pick 4 sales.

The Pick 3 Green Ball and Pick 4 Red Ball promotions may create a temporary boost in sales after the promotions end. Lottery officials often mention the need to add excitement to their games in order to encourage lapsed lottery players to take another look at particular lottery games. There may be some element of habit or routine involved in buying daily lottery tickets, so the promotions may increase sales even after the last day of the promotion. We include both a dummy variable for the first 45 days after the end of the Green Ball promotion and a variable equal to 45 minus the number of days since the end of the Green Ball promotion, for 45 days, to capture any temporary boast in sales from the Pick 3 Green Ball promotion. Similarly, we include dummy variable for the first 45 days after the end of the Red Ball promotion and a variable equal to 45 minus the number of days since the end of the Red Ball promotion, for 45 days, to capture any temporary boast in sales from the Pick4 Red Ball promotion. This specification allow for a general boast in sales after the end of a promotion as well as an increase in sales that is larger immediately after a promotion ends.

We include the natural logarithm of the Mega-Millions jackpot in millions of dollars to test the effects of random variation in the size of the Mega-Millions jackpot on Pick 3 and Pick 4 lottery sales. Excitement generated by large jackpots in the famous Mega-Millions game may affect Pick 3 and Pick 4 sales. If Mega-Millions is a complement to daily number games Pick 3 and Pick 4 sales may increase with the size of the Mega-Millions jackpot. However, there could be the opposite effect if Mega-Millions is a substitute product for Pick 3 and Pick 4 in the eyes of lottery players.

To many people Friday is a wonderful day because it is payday and the start of the weekend. If some consumers desire to use their paycheck to play Pick 3 and Pick 4, then Friday sales may be strong. Credit constrained lottery players may be unable to play until they receive a paycheck on Friday. Many counties in New Jersey prohibit shopping malls from opening on Sundays, despite New Jersey's fame as the home of so many shopping malls. Pick 3 and Pick 4 sales may be lower on Sundays because that is not a normal Jersey shopping day. We will use six binary, dummy variables for each day from Monday to Saturday to control for day of week effects. The variable for Monday = 1 when the drawing is held on a Monday and the dummy variable Monday = 0 on all other days. Sunday is the omitted day of the week.

Credit constraints may also affect consumers on a monthly basis. If consumers are waiting for a check to arrive on the first of the month and are credit constrained, then we would expect sales to be higher at the beginning of the month. Therefore we include a dummy variable for the first five days of a month. Similarly, sales at the end of the month may be lower because lottery players may be out of cash. We include a dummy variable for the last five days of the month to account for this possible effect.

We include a dummy variable for July 1 and July 2, 2006, the days before the New Jersey government shutdown from July 3 to July 7, 2006 due to a budget dispute between the N.J. Governor and the legislature. This allows us to test whether lottery players anticipated a government shutdown from media coverage of the budget impasse that closed both the New Jersey Lottery and Atlantic City casinos. We hypothesis that lottery sales should increase if lottery players anticipate the lottery will close. We also omit July 3 to July 7, 2006 and Christmas day in all years from our regression model because there were no lottery drawings held on those days.

Lottery sales may be affected by the weather. We hypothesize that rain or snow will reduce lottery sales because people may reduce shopping trips. We include the daily precipitation measured at the Newark, N.J. airport in the regression models.

Consumer shopping patterns and purchases of Pick 3 and Pick 4 lottery tickets may be affect by holidays. Therefore, we include separate dummy variables for the day of New Jersey state holiday, the day before a holiday, and the day after a holiday.

Our dataset allow us to test whether daily sales of Pick 3 and Pick 4 respond to high frequency changes in the stock market. We include a dummy variable in the regression models for the evening Pick 3 and evening Pick 4 for days when the Dow Jones Industrial Index increased one percent or more. We also include a dummy variable in the regression models for the evening Pick 3 and evening Pick 4 for days when the Dow Jones Industrial Index declines one percent or more.

We include natural logarithm of the monthly seasonally adjusted New Jersey unemployment rate to control for changes in the labor market potentially affecting lottery sales.

Finally, we include a time trend in the regressions to account for any general rise or decline in the popularity of particular daily lottery drawings in New Jersey.

We model the error structure with an AR(1) specification. This choice is motivated by possible daily and weekly lottery ticket purchasing habits. Lottery prizes are validated and lottery prizes under $599.50 are paid in cash at New Jersey Lottery retailers. Higher sales lead to a large dollar volume of lottery prize payments. Large lottery sales volume on one day may lead to higher sales volume the next day as holders of lottery tickets return to a lottery retailer to cash in their winning tickets and then use a portion of their winnings to buy additional lottery tickets

The regression results are reported in Table 5. Table 6 reports the percentage changes from the semilogarithmic regression with dummy regressors for statistically significant dummy variables.

The own-price elasticity of demand for both evening Pick 3 and Pick 4 games are inelastic. The evening Pick 3 game has an own-price elasticity of demand of -0.5. The evening Pick 4 game has an own-price elasticity of demand of -0.57. These results show that the promotions increase sales of the targeted evening lottery games by a smaller percentage than the reduction in the price of the lottery game caused by the additional prize payments. The inelastic demand for these lottery games means that the increased volume of sales of the promoted lottery games during the period of the Green Ball or Red Ball promotion is outweighed by the cost to the state of reducing the price of these games during the promotions.

The inelastic response of sales even on days when only a promotional ball is left in the secondary drawing hopper is surprising. When no white balls are left in the drawing, lottery players are assured of prize payments being doubled for the evening drawing targeted in the promotion. However, as shown in the fifth column of Table 1 evening Pick 3 sales increase only about 26.4% from $785,896 to $993,718 comparing no Green Ball promotion to an average evening when a Green Ball is certain to be drawn. The sixth column of Table 2 shows that evening Pick

4 sales increase from $481,193 to $708,523 comparing no Red Ball promotion to an average evening when a Red Ball is certain to be drawn. This is a 47.2% increase.

Sales of Pick 3 evening lottery tickets are not affected by the Red Ball promotion and its reduction in the price of evening Pick 4 tickets. The cross-price elasticity of evening Pick 3 sales with respect to the evening Pick 4 price is not statistically different than zero. Also, evening Pick 3 sales do not show any change during the first 45 days after the end of the Red Ball promotion.

The Green Ball promotion increases sales of Pick 4 evening lottery tickets both during the promotion and during the 45 days following the end of the promotion. The cross-price elasticity of demand for evening Pick 4 game with respect to the price of the Pick 3 evening game is -0.18. In addition, evening Pick 4 sales are increased after the end of the Green Ball promotion.

The Green Ball promotion also increases the sale of midday Pick 3 and midday Pick 4 games. The cross-price elasticity of demand for midday Pick 3 game with respect to the price of the Pick 3 evening game is -0.19. The cross-price elasticity of demand for midday Pick 4 game with respect to the price of the Pick 3 evening game is -0.08. These results are interesting and surprising. The better odds of the Pick 3 game for the evening drawing during the Green Ball promotion actually increases the sale of the midday lottery games. The Green Ball drawing stimulates higher sales for the evening and midday Pick 3 drawings and even the evening and midday Pick 4 drawings for 45 days after the promotion's end. This effect is stronger for Pick 3 sales than Pick 4 sales.

The Red Ball promotion increases Pick 4 midday sales. The cross-price elasticity of demand for midday Pick 4 game with respect to the price of the Pick 4 evening game is -0.11. Pick 4 midday sales increase by 5.7% during the 45 days after the end of the Red Ball promotion.

The Pick 4 price does not have a statistically significant effect on evening Pick 3 sales. This result suggests that the evening Pick 4 game is neither a substitute nor a complement for the evening Pick 3 game.

The Red Ball promotion does have a modest negative effect on midday Pick 3 sales. The cross price elasticity of midday Pick 3 sales with respect to the Pick 4 price is 0.07. This result is statistically significant at the 95% confidence level, but not at the 99% confidence level.

The drawing after a Green Ball is drawn has higher sales for all four lottery games. The point estimates of the percentage change in the sales for the day after a Green Ball is drawn range between 3.3% for Pick 4 evening sales to 5.5% for Pick 3 midday sales as shown in Table 6. This is evidence that some lottery players use the additional prize payments from the payment of prizes for two sets of winning numbers in the Green Ball promotion to buy additional lottery tickets the following day. In contrast, there does not appear to be a similar increase in lottery sales the day after a Red Ball is drawn. For the Pick 4 evening drawing the estimated 2.5% increase in sales is statistically significant at only a 90% confidence level. The coefficients are not statistically different from zero at the 95% confidence level for all four lottery games.

There is a very small positive effect of the size of the Mega-Millions jackpot on evening Pick 3 and Pick 4 sales. The elasticity of evening Pick 3 sales with respect to the size of the Mega-Millions jackpot is only 0.007. The elasticity of evening Pick 4 sales with respect to the size of the Mega-Millions jackpot is 0.006. Even large percentage increases in the size of the Mega-Millions jackpot result in only tiny increases in evening Pick 3 and Pick 4 sales. Midday Pick 3 and Pick 4 sales are not affected by the size of the Mega-Millions jackpot.

There are strong day of week effects. Friday is the most popular day of the week for daily lottery games   Sunday, the omitted day of the week, is the least popular day of the week for daily lottery games. Table 6 summarizes the day of week effects in terms of the percentage change compared to the omitted day Sunday. For example, Pick 3 evening sales on Fridays are 37.1% higher than on Sundays. The day of week effects are much larger for the evening lottery games than for the midday drawings.

Sales of all four lottery games are higher during the first five days of the month. Pick 3 evening sales are 4.2% higher and Pick 3 midday sales are 4.0% higher at the start of the month. Pick 4 evening sales are 3.3% higher and Pick 4 midday sales are 3.7% higher at the start of the month. Both the strong Friday sales effect and higher sales at the beginning of the month are suggest that at least some New Jersey Pick 3 and Pick 4 lottery players are credit constrained.

There were large increases both Pick 3 and Pick 4 lottery sales before the July 2006 New Jersey government shutdown that shut down the lottery for 5 days. These increases were larger for the evening games than the midday games. Evening Pick 3 sales increased 42.7%, while evening Pick 4 sales increase 43.5% for the two days before the government shutdown. Midday Pick 3 sales increased 29.8%, while midday Pick 4 sales increased 28.9% prior to the government shutdown. It appears lottery players anticipated that a political stalemate could shut down the lottery and bought extra tickets while the lottery still was operating.

A rainy day has a small negative effect on sales of all four New Jersey Lottery games. The elasticity of Pick 3 and Pick 4 sales with respect to daily precipitation in Newark is approximately -0.02 for all games.

Daily changes in the stock market have a very small effect on evening Pick 3 and Pick 4 sales. The dummy variables for days when the Dow Jones Industrial Average increased at least one percent is statistically significant at the 95% level for both Pick 3 and Pick 4. The dummy variable for days when the DJIA falls more than one percent is also statistically significant at 95% level for evening Pick 4 sales, but not evening Pick 3 sales. The magnitude of these effects is small. Evening Pick 3 and Pick 4 sales are about one percent higher on days when the DJIA increased one percent or more. Evening Pick 4 sales are 0.9% higher on days when the DJIA declines one percent or more.

The results for the unemployment rate are somewhat contradictory. The elasticity of Pick 4 evening sales with respect to the New Jersey seasonally adjusted unemployment rate is 0.06. In contrast, the elasticity of Pick 3 midday sales with respect to the New Jersey seasonally adjusted unemployment rate is -0.09. The unemployment rate does not have an effect on evening Pick 3 or midday Pick 4 sales that is statistically significant at a 95% confidence level.

Sales decline on holidays. Evening Pick 3 sales are 8.7% lower on holidays. Evening Pick 4 sales are 8.6% on holidays. Midday Pick 3 sales are 3.5% lower on holidays. Midday Pick 4 sales are 4% lower on holidays. Midday lottery sales are about 2.6% lower the day before a holiday. The day after a holiday sales are approximately 2.5% higher.

The time trend is slightly negative for evening Pick 3 sales and slightly positive for midday Pick 3 sales. The time trend is also slightly negative for evening Pick 4 sales and slightly positive for midday Pick 4 sales.

5. Conclusion and Directions for Future Research

The Green Ball and Red Ball promotions attempt to increase New Jersey state lottery profits by expanding volume at the expense of profit margin. A 2005 New Jersey Lottery's press release about these promotions claim "sales from the Green Ball Double Draw promotion alone led to an additional $1.1 million in funding for important state programs such as college scholarships, school nutrition programs and veterans homes."[11] It also claims that "During this year's promotion, which took place from March 7-29, the green ball was drawn seven times, leading to an additional 29,208 Pick 3 winners and $3.2 million in additional Pick 3 prizes" and "Pick 3 sales were up 5.99% in March 2005 compared to March 2004, with a total sales increase of $2.372 million." This math does not add up.

The percentage price reduction during the promotions is greater than the percentage increase in sales during the promotions. Due to the estimated inelastic demand the promotions reduce both revenue and profits for the New Jersey Lottery during the promotions. These promotions do provide a temporary boost in the sales of daily lottery games for 45 days after the end of the promotions. Future work will explore whether the longer-lasting increases in sales is worth the loss of lottery profit during these promotions.

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[11] "New Jersey's Pick 3 Players Follow the Green Ball to Riches! Pick 3 Players Win An Additional $3 Million During Green Ball Double Draw." New Jersey Lottery Press Release. April 28, 2005.

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Table 1: The Expected Value and Price of Pick 3 Lottery Tickets Vary with the Number of White Balls during a Green Ball Promotion

Number of White Balls	Odds of a Green Ball	Expected Value of a Dollar Bet	Cost of a Dollar of Expected Winnings	Average Evening Pick 3 Sales	Average Evening Pick 4 Sales	Average Midday Pick 3 Sales	Average Midday Pick 4 Sales	Number of Observations
6	0.143	$ 0.571	$ 1.750	$ 875,652	$ 505,720	$ 479,814	$ 236,974	32
5	0.167	$ 0.583	$ 1.714	$ 851,886	$ 490,480	$ 453,201	$ 224,080	32
4	0.200	$ 0.600	$ 1.667	$ 880,228	$ 505,948	$ 465,607	$ 230,911	27
3	0.250	$ 0.625	$ 1.600	$ 878,987	$ 496,745	$ 464,746	$ 228,672	23
2	0.333	$ 0.667	$ 1.500	$ 865,947	$ 479,331	$ 439,519	$ 215,834	12
1	0.500	$ 0.750	$ 1.333	$ 967,209	$ 507,490	$ 458,026	$ 221,416	7
0	1.000	$ 1.000	$ 1.000	$ 993,718	$ 533,316	$ 481,413	$ 234,405	2
During Promotion	0.226	$ 0.613	$ 1.644	$ 877,136	$ 498,779	$ 463,409	$ 228,567	135
Outside of Promotion		$ 0.500	$ 2.000	$ 785,896	$ 482,490	$ 437,463	$ 221,705	1605
Entire Sample				$ 792,917	$ 483,727	$ 439,487	$ 222,247	1740
The day after a Green Ball is drawn with 6 white balls	0.143	$ 0.571	$ 1.750	$ 882,777	$ 505,149	$ 486,197	$ 238,812	28
Not on a day after a Green Ball is drawn with 6 white balls	0.143	$ 0.571	$ 1.750	$ 825,781	$ 509,717	$ 435,131	$ 224,102	4

Table 2: The Expected Value and Price of Pick 4 Lottery Tickets Vary with the Number of White Balls during a Red Ball Promotion

Number of White Balls	Odds of a Red Ball	Expected Value of a Dollar Bet	Cost of a Dollar of Expected Winnings	Average Evening Pick 3 Sales	Average Evening Pick 4 Sales	Average Midday Pick 3 Sales	Average Midday Pick 4 Sales	Number of Observations
6	0.143	$ 0.571	$ 1.750	$ 763,079	$ 521,857	$ 441,022	$ 235,152	21
5	0.167	$ 0.583	$ 1.714	$ 700,866	$ 480,210	$ 411,658	$ 218,829	19
4	0.200	$ 0.600	$ 1.667	$ 767,934	$ 535,439	$ 428,083	$ 229,850	14
3	0.250	$ 0.625	$ 1.600	$ 813,635	$ 574,409	$ 448,025	$ 240,729	12
2	0.333	$ 0.667	$ 1.500	$ 794,822	$ 562,914	$ 449,580	$ 239,262	10
1	0.500	$ 0.750	$ 1.333	$ 759,627	$ 559,526	$ 435,400	$ 232,977	6
0	1.000	$ 1.000	$ 1.000	$ 798,723	$ 708,523	$ 442,384	$ 240,922	2
During Promotion	0.242	$ 0.621	$ 1.629	$ 761,419	$ 534,231	$ 433,874	$ 231,844	84
Outside of Promotion		$ 0.500	$ 2.000	$ 794,576	$ 481,193	$ 439,760	$ 221,749	1656
Entire Sample				$ 792,917	$ 483,727	$ 439,487	$ 222,247	1740
The day after a Red Ball is drawn with 6 white balls		$ 0.571	$ 1.750	$ 761,909	$ 523,200	$ 444,150	$ 237,083	18
Not on a day after a Red Ball is drawn with 6 white balls		$ 0.571	$ 1.750	$ 770,098	$ 513,799	$ 422,252	$ 223,566	3

Table 3: Descriptive Statistics for Sample Used in Regressions

	Mean	Maximum	Minimum	Std. Dev.
Evening Pick 3 Sales	$ 792,975	$1,082,122	$447,325	86411
Evening Pick 4 Sales	$ 483,754	$ 809,328	$241,487	55459
Midday Pick 3 Sales	$ 439,476	$ 561,467	$185,230	42228
Midday Pick 4 Sales	$ 222,237	$ 578,795	$ 88,124	22848
Price of Evening Pick 3	$ 1.972	$ 2.00	$ 1.00	0.102
Price of Evening Pick 4	$ 1.982	$ 2.00	$ 1.00	0.086
Dummy Variable for Day After Green Ball is Drawn	0.020	1	0	0.140
Dummy Variable for Day After Red Ball is Drawn	0.011	1	0	0.104
Evening Pick 3 Straight Prize Payments	$ 260.85	$ 430.50	$ 72.00	52.13
Midday Pick 3 Straight Prize Payments	$ 262.92	$ 455.00	$ 99.00	53.93
Evening Pick 4 Straight Prize Payments	$2,721.62	$ 7,782.00	$ 646.00	734.12
Midday Pick 4 Straight Prize Payments	$2,757.27	$ 6,398.50	$ 394.50	751.88
Number of Days Since End of Green Ball Promotion	2.47	45	0	8.20
Number of Days Since End of Red Ball Promotion	1.77	45	0	7.11
Mega-Millions Jackpot (in millions)	62.3	370	10	57.8
First 5 Days of Month Dummy	0.164	1	0	0.371
Last 5 Days of Month Dummy	0.164	1	0	0.370
Last 2 Days Before Government Shutdown Dummy	0.0006	1	0	0.024
Daily Precipitation in Newark	0.13	6.18	0	0.40
Dow Jones Up 1% or More Dummy	0.080	1	0	0.271
Dow Jones Down 1% or More Dummy	0.068	1	0	0.253
New Jersey Unemployment Rate Seasonally Adjusted	4.9	8.4	4.2	0.95
Day of New Jersey Holiday Dummy	0.033	1	0	0.180

N=1740

Table 4: Augmented Dickey-Fuller Tests Unit Root Test: Null Hypothesis is a Unit Root in the Level of the Variable

Variable	t-statistic	p-value
Pick 3 evening	-5.16	0.000
Pick 4 evening	-5.54	0.000
Pick 3 midday	-5.16	0.000
Pick 4 midday	-4.48	0.000

Table 5: Estimated Demand for Pick 3 and Pick 4 New Jersey Lottery Tickets

	Log (Evening Pick 3 Sales)	Log (Evening Pick 4 Sales)	Log (Midday Pick 3 Sales)	Log (Midday Pick 4 Sales)
Constant	13.69***	13.22***	12.99***	12.22***
	(-0.049)	(0.0462)	(0.0434)	(0.0376)
Log (Pick 3 Evening Price)	-0.5006***	-0.1791***	-0.1885***	-0.0848***
	(0.0427)	(0.0264)	(0.0357)	(0.0326)
Log (Pick 4 Evening Price)	0.0196	-0.567***	0.0698**	-0.1137***
	(0.0428)	(0.0383)	(0.0279)	(0.0218)
Dummy Variable for Day After a Green Ball is Drawn	0.0483***	0.0322***	0.0533***	0.0399***
	(.00087)	(0.0081)	(0.0103)	(0.0094)
Dummy Variable for Day After a Red Ball is Drawn	-0.0075	0.0251*	-0.0124	0.0174
	(0.0124)	(0.0151)	(0.0105)	(0.0125)
Pick 3 Evening Straight Pari-Mutual Prize for the Previous Day	0.00002		0.000010	
	0.000022		(0.000018)	
Pick 3 Midday Straight Pari-Mutual Prize for that Day	0.000014		0.000019	
	0.000022		(0.000017)	
Pick 3 Midday Straight Pari-Mutual Prize for the Previous Day			0.000003	
			(0.00002)	
Pick 4 Evening Straight Pari-Mutual Prize for the Previous Day		0.0000016		-0.0000027*
		(0.0000018)		(0.0000015)
Pick 4 Midday Straight Pari-Mutual Prize for that Day		0.0000036		
		(0.0000018)*		
Pick 4 Midday Straight Pari-Mutual Prize for the Previous Day				0.0000034**
				(0.0000015)
Dummy Variable for the first 45 days after the end of a Green Ball Promotion	0.0904***	0.0484***	0.0738***	0.0430***
	(0.0057)	(0.0061)	(0.0064)	(0.0055)
45 - Number of Days after Green Ball Promotion (for 45 days)	0.0016***	0.0010***	0.0010***	0.0005**
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Dummy Variable for the first 45 days after the end of a Red Ball Promotion	-0.0085	0.0551***	-0.0213**	0.0187**
	(0.0091)	(0.0095)	(0.0102)	(0.0092)
45 - Number of Days after Red Ball Promotion (for 45 days)	-0.005	0.0003	-0.0006	0.000002
	(0.0003)	(0.0003)	(0.0004)	(0.0003)
Log(Mega-Millions jackpot in millions)	0.0067***	0.0056***	0.0031	0.0004
	(0.0017)	(0.0020)	(0.0019)	(0.0020)

	Log (Evening Pick 3 Sales)	Log (Evening Pick 4 Sales)	Log (Midday Pick 3 Sales)	Log (Midday Pick 4 Sales)
Monday Dummy	0.1935***	0.2414***	0.0565***	0.0889***
	(0.0045)	(0.0055)	(0.0042)	(0.0049)
Tuesday Dummy	0.1542***	0.1754***	0.0628***	0.0783***
	(0.0049)	(0.0057)	(0.0046)	(0.0050)
Wednesday Dummy	0.1587***	0.1673***	0.0739***	0.0863***
	(0.0046)	(0.0052)	(0.0050)	(0.0054)
Thursday Dummy	0.2347***	0.2578***	0.1240***	0.1376***
	(0.0046)	(0.0051)	(0.0048)	(0.0050)
Friday Dummy	0.3156***	0.3307***	0.2101***	0.2280***
	(0.0049)	(0.0063)	(0.0050)	(0.0062)
Saturday Dummy	0.2013***	0.2005***	0.1910***	0.1884***
	(0.0040)	(0.0047)	(0.0046)	(0.0050)
First 5 Days of the Month Dummy	0.0413***	0.0327***	0.0395***	0.0359***
	(0.0041)	(0.0044)	(0.0050)	(0.0045)
Last 5 Days of the Month Dummy	-0.0051	-0.0002	-0.0055	-0.0024
	(0.0034)	(0.0039)	(0.0040)	(0.0036)
Last 2 Days Before Government Shutdown Dummy	0.3555***	0.3611***	0.2607***	0.2540***
	(0.0049)	(0.0069)	(0.0051)	(0.0050)
Daily Precipitation in Newark	-0.0221***	-0.0212***	-0.0210***	-0.0198***
	(0.0031)	(0.0037)	(0.0039)	(0.0043)
Dow Jones Up 1% or More Dummy	0.0083**	0.0095**		
	(0.0035)	(0.0044)		
Dow Jones Down 1% or More Dummy	0.0056	0.0089**		
	(0.0040)	(0.0043)		
Log (NJ Unemployment Rate SA)	-0.0196*	0.0613***	-0.0885***	-0.0005
	(0.0109)	(0.0114)	(0.0137)	(0.0121)
Day of NJ Holiday Dummy	-0.0911***	-0.0897***	-0.0352***	-0.4047***
	(0.0167)	(0.0182)	(0.0110)	(0.0116)
Day Before NJ Holiday Dummy	-0.0120*	-0.0074	-0.0253***	-0.0273***
	(0.0065)	(0.0064)	(0.0072)	(0.0071)
Day after NJ Holiday Dummy	0.0227***	0.0273***	0.0260***	0.0275***
	(0.0086)	(0.0102)	(0.0074)	(0.0084)
Trend	-0.000036***	-0.00004***	0.000077***	0.000075***
	(0.000003)	(0.000004)	(0.000007)	(0.000004)
AR(1)	0.2297***	0.1739***	0.4003***	0.2833***
	(0.0377)	(0.0463)	(0.0563)	(0.0563)
R-squared	0.8185	0.7594	0.7868	0.7336
Adjusted R-squared	0.8154	0.7553	0.7834	0.7293
F-Statistic	263.7	184.6	232.1	173.2
Durbin-Watson stat	2.070	2.053	2.166	2.117

Table 6: Percentage Change in Sales Due to Statistically Significant Dummy Variables

	Percentage Change in Evening Pick 3 Sales	Percentage Change in Evening Pick 4 Sales	Percentage Change in Midday Pick 3 Sales	Percentage Change in Midday Pick 4 Sales
Dummy Variable for Day After a Green Ball is Drawn	4.9%	3.3%	5.5%	4.1%
Dummy Variable for Day After a Red Ball is Drawn		2.5%		
Dummy Variable for the first 45 days after the end of a Green Ball Promotion	9.5%	5.0%	7.7%	4.4%
Dummy Variable for the first 45 days after the end of a Red Ball Promotion		5.7%		
Monday Dummy	21.3%	27.3%	5.8%	9.3%
Tuesday Dummy	16.7%	19.2%	6.5%	8.1%
Wednesday Dummy	17.2%	18.2%	7.7%	9.0%
Thursday Dummy	26.5%	29.4%	13.2%	14.8%
Friday Dummy	37.1%	39.2%	23.4%	25.6%
Saturday Dummy	22.3%	22.2%	21.0%	20.7%
First 5 Days of the Month Dummy	4.2%	3.3%	4.0%	3.7%
Last 2 Days Before Government Shutdown Dummy	42.7%	43.5%	29.8%	28.9%
Dow Jones Up 1% or More Dummy	0.8%	1.0%		
Dow Jones Down 1% or More Dummy		0.9%		
Day of NJ Holiday Dummy	-8.7%	-8.6%	-3.5%	-4.0%
Day Before NJ Holiday Dummy			-2.5%	-2.7%
Day after NJ Holiday Dummy	2.3%	2.8%	2.6%	2.8%

Note: These percentage changes were calculated as $((e^B - 1) * 100)$, where B is the dummy coefficient from the semilogarithmic regression, where sales are in logs and the regressor is a binary dummy variable.

Figure 1: Evening Pick 3 Sales and the Price of Evening Pick 3 Winnings
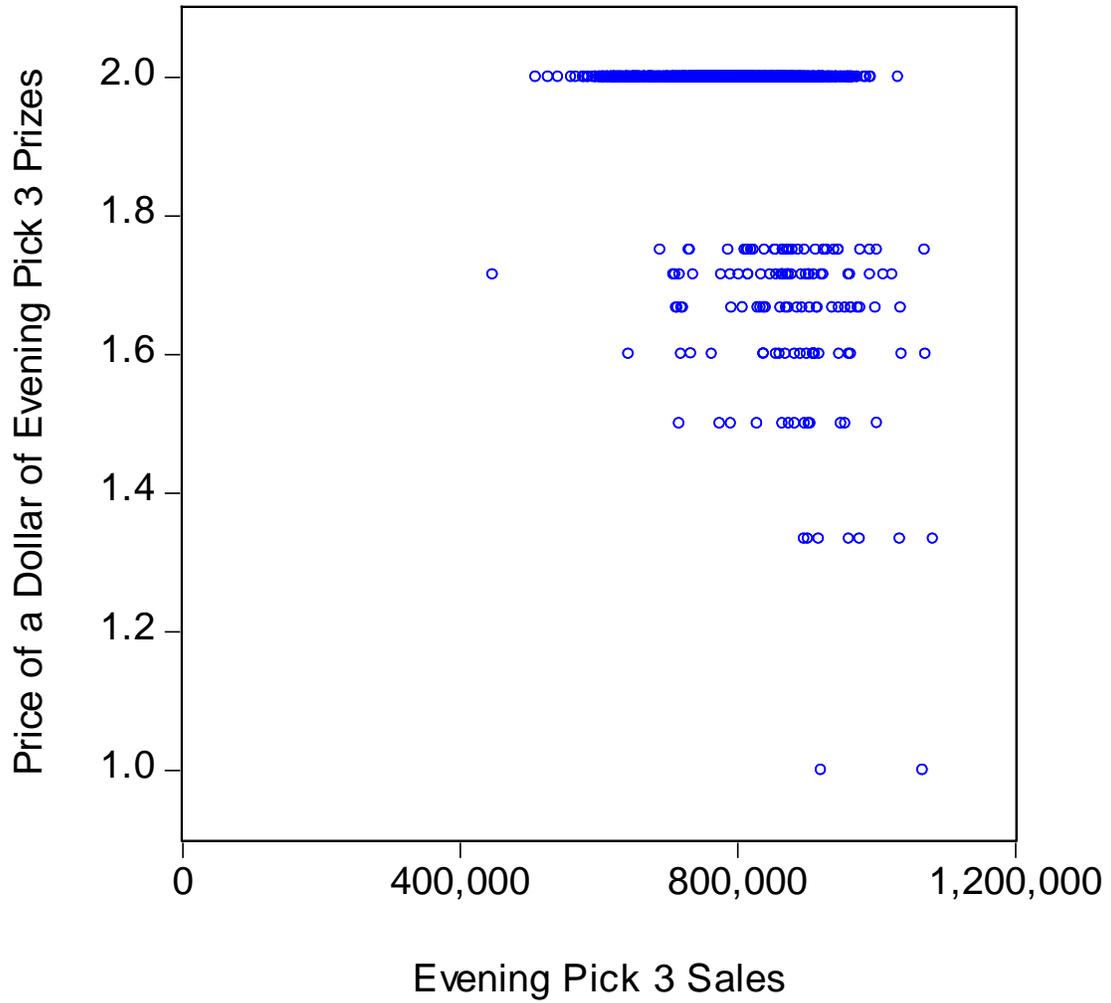
N=1656 Sample of Days with Evening Drawings and without a Red Ball Pick 4 Promotion

Figure 2: Evening Pick 4 Sales and the Price of Evening Pick 4 Winnings

N=1605 Sample of Days with Evening Drawings and without a Green Ball Pick 3 Promotion