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THE HISTORY OF A LOTTERY GAME THAT WAS SELDOM WON

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Lotto Extra was offered as part of the United Kingdom National Lottery's portfolio of games between 2000 and 2006. A demand model for the game is estimated and used to illustrate a discussion of why sales of the game fell steadily to the point where it was no longer viable. Emphasis is placed on the lack of minor prizes and the long sequences of weeks when no one won the jackpot (and only) prize.

INTRODUCTION

The United Kingdom National Lottery, operated by Camelot, began in 1994. Its history has followed a similar trajectory to that of lotteries inaugurated in American states and other jurisdictions around the world in the nineteen-eighties. It first offered only a Saturday lotto game but quite quickly added a midweek draw and scratchcards. Subsequently, it has steadily broadened the portfolio of on-line games to attempt to replace sales of the main lotto draw, which have declined in the face of waning public interest. Games introduced included Thunderball, Daily Play and Euromillions, all of which remain on sale. However, two new products failed in the sense that they have not survived in the portfolio. A discussion of the reasons for the quick demise of the first of these, Easy Play, a lotto style game linked to football results, was provided by Forrest (1999). Here, we consider the second, Lotto Extra, which was launched in November, 2000 but withdrawn in July, 2006.

Lotto Extra had a familiar structure to the extent that there were Wednesday and Saturday draws where players were invited to select 6 numbers from 49; if none was successful in matching all six balls selected at random, the prize fund was 'rolled over', ie added to that for the next draw. However, Lotto Extra possessed several distinctive features which make analysis of its sales history potentially illuminating with respect to understanding of the lottery market. First, it was a jackpot-only game; 45% of sales revenue was paid into the prize fund and all of that was used for the jackpot prize. Evidently, with no lower tier prizes, it was designed to appeal to a niche market of those who had a very strong preference for skewness in returns.[1] Second, it could not be purchased as a stand-alone product but only in conjunction with a ticket for the main Lotto draw: one Lotto Extra ticket could be bought for each Lotto entry made in the same transaction. Third, although the odds were the same as in Lotto, the lower level of sales achieved meant that it was won extraordinarily infrequently. The extreme case was that, in a period up to October, 2004, 104 consecutive Wednesday draws passed without there being a winner.

These features provide the opportunity to observe the behaviour of consumers in situations seldom or never encountered in other lotteries. For example, because there were several long sequences of draws without a winner, rollovers accumulated to the point where some draws offered a (very) good bet, with the expected value of holding a one pound ticket rising to as high as £1.40. The relatively low response of sales observed[2] may illustrate just how few risk-neutral agents populate the economy. Again, behaviour of sales in the face of long periods without a winner is of interest in itself because it is conventional wisdom in the lottery industry that, while a game should be hard enough to generate occasional rollovers that boost public interest, it should not be too hard because players lose heart if no one wins. Here, we can test for the latter effect because there was no cap on the number of consecutive rollovers.[3] Further, it is possible to distinguish the effects of expected value and the number of weeks without a winner. For example, during the two year period when no one won the Wednesday prize, jackpot did not increase monotonically because prize money rolled over not to the following Wednesday but into the Saturday in between when sometimes it was in fact paid out. Consequently, the size of jackpot and the expected value of a ticket were only weakly correlated with the number of weeks since the last winner (correlation coefficients for Wednesday and Saturday each in the range 0.25 to 0.30).

Our main discussion of what can be learned from the experience of Lotto Extra will be illustrated by the results of a demand model. In its construction, we exploit sales data from the first to the penultimate draw. We exclude from our data set information on the final play of the game when conditions might be expected to have been untypical. In fact, what was offered on the close-down date, July 8, 2006, was essentially a different product: if the jackpot was not won, it was to be shared amongst those with five of the six balls matched. In the event, seventeen such ticket holders shared the last day prize money. It is of interest, and suggestive, that this final play of the game enjoyed sharply raised ticket sales.

DEMAND MODEL

The sales data to be analysed are presented as Figure 1. Inspection of the raw data suggests a strong downward trend in both Wednesday and Saturday games, with substantial variation around the trend as rollovers have their impact on perceived value for money. These features will be incorporated in our econometric model.

Gulley and Scott (1993) provided a formal framework for those who have analysed the market for lotto games in Britain and elsewhere.[4] Their insight was that the structure of a lotto style game, whereby if the jackpot is not won it is carried forward to the next play, generates significant variation in value for money across draws. A rollover adds 'free' money to the pot in the sense that it is not provided by this week's players who therefore purchase a product with elevated expected value. From a measure of how strongly sales respond to improved expected value it may be possible to infer whether improved pay-

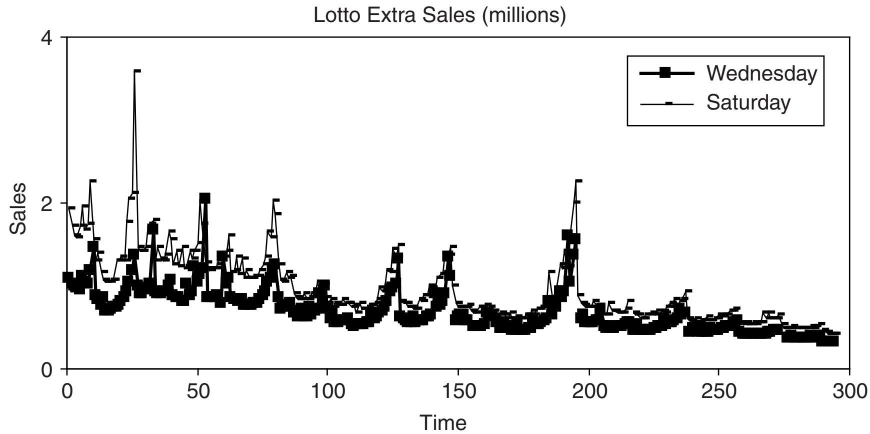

FIGURE 1. Sales history of Lotto Extra.

outs in regular draws would pay for themselves from increased revenue (ie it is possible to estimate elasticity of demand with respect to effective price[5]) and more general insights may be obtained from the results on control variables in the model.

Applying the Gulley- Scott model to the Lotto Extra case, we estimate the following sales equation for the Wednesday game[6]:

$$q = \mathrm{f}(\text{constant},\ q^{w(-1)},\ q^{w(-2)},\ q^{w(-3)},\ q^{w(-4)},\ q^{w(-5)},\ Q_s,\ TREND^2,\ WKSSINCEWIN,\ PRICE,\ PRICELOTTO) \tag{1}$$

q is the natural log of the number and pound value of sales. $q^{w(-1)}$ to $q^{w(-5)}$ are lagged dependent variables, included to capture habit persistence, and Q_s represents sales in the immediately preceding (Saturday) draw.[7] Trend and its square are often included in lotto demand equations to capture a tendency for sales to rise at first after the inception of the game but then to turn down as boredom and disillusion set in; but here *TREND* was insignificant in preliminary estimation and use of its square alone better captured the (downward) trajectory of sales. The variable, *WKSSINCEWIN* is the number of consecutive previous Wednesdays that had produced no winner. *PRICE* is the 'effective price' of a Lotto Extra ticket, defined as the expected loss from purchase. *PRICELOTTO* is similarly defined for tickets in the same day's main Lotto draw. By linking the purchases of Lotto and Lotto Extra, Camelot hoped to minimise cannibalisation of the older game but, in principle, the two could be complements or substitutes (for example, if there were a large jackpot in Lotto, Extra sales could rise because more people would visit the sales booths but could fall because some regular Extra players spent all their lottery budget on tickets for the main draw).[8]

PRICE is one minus the expected value (EV) of prize money for a single ticket holder. It is measured for the points in time at which sales in each draw closed, i.e. when the number of tickets sold had been determined. Expected value varies with the level of sales because the latter influences the probability that the prize money will be won at all. Adapting Cook and Clotfelter (1993), *PRICE* was calculated as follows:

$$(2) \qquad PRICE = 1 - EV = 1 - (1/Q)(R + jQ + B)(1 - e^{-pQ})$$

where Q is level of sales, R is amount rolled over into the prize pool from the preceding draw, j is the proportion of sales revenue paid into the jackpot (here the only) prize pool, B is bonus money added to the prize by the operator[9] and p is the probability of a single entry matching all six numbers and therefore winning. In the case of Lotto Extra, j was set at 0.45 throughout while p (given the 6/49 game format) was close to 1 in 14 million.

In (2) the first part of the expression for EV represents the amount per ticket in the jackpot pool while $(1 - e^{-pQ})$ represents the probability that the prize will be paid out (rather than rolled over to the benefit of future players). Given the level of sales achieved for the game, the probability of the prize being paid out was always low; for example in the first draw only 1.09m tickets were sold whereas there are 13.98m combinations of six numbers from which to choose. This accounts for very low expected value/ high price in some draws of Lotto Extra compared with other lottery games. On the other hand, long sequences without a winner led to the prize accumulating to high levels and it was sometimes added to by the operator, so that the game became a good bet, i.e price became negative. Thus the range of price observed in our data set is much wider than for lottery games previously studied in the literature (from − £0.36 to +£0.93 on Wednesdays).

We hypothesise that the sales of Lotto Extra depended not only on own price but also on the value for money available from the day's main lotto draw. *PRICELOTTO* was calculated similarly to that for Lotto Extra except that account had to be taken of the existence of smaller prizes. The rules of the game are that 45% of sales revenue, along with any rollover or 'superdraw' bonus, is paid into the prize fund. Fixed £10 prizes are given to ticket holders who match exactly three of the six balls. What remains of the prize fund is then divided, 52% to the (match-six) jackpot and 48% to be split in pre-determined proportions between second- third- and fourth-tier winners.[10] Thus the formula for calculating price became:

$$\begin{aligned} PRICELOTTO &= 1 - EV \\ &= 1 - [10p_3 + (1/Q)(.52Q(.45 - 10p_3) + R + B) \\ (3) \qquad &\quad \times (1 - e^{-pQ}) + (1/Q)(.48Q(.45 - 10p_3))] \end{aligned}$$

where p_3 is the probability of matching exactly three numbers (approximately 1 in 57).

In light of this discussion, it is clear that ordinary least squares estimation of our sales equation, (1), is inappropriate. *PRICE* is endogenous since it depends on sales (and, further, players have to forecast it when deciding on level of purchase as its exact value emerges only ex post). Gulley and Scott therefore proposed estimation by two stage least squares. *ROLLOVER*, the amount rolled over from the previous draw provides a convenient instrument for *PRICE*. In the UK environment, a potential additional instrument is the amount of money added to the prize fund as part of a 'superdraw'. However, while the decision to add a bonus to the jackpot might be treated as exogenous, its amount cannot be since in practice the operator offered not a specific sum of money but rather a top-up to allow the jackpot to reach some advertised guaranteed level. The amount of bonus money therefore itself depended on sales. Instead of the amount of bonus money, we use as instruments dummy variables to represent particular levels of guarantee. These variables, *guaranteeone* and *guaranteefour* refer to occasions when there were guaranteed jackpots of £1m and £4m respectively (the £1m jackpot was invariably on offer when no rollover money had been carried forward from the previous Saturday).[11]

LOTTOPRICE is also in principle endogenous since sales of Lotto Extra could affect sales, and therefore the price, of Lotto. Instruments used are amount rolled over from the previous lotto draw (*LOTTOROLLOVER*) and dummy variables (*lottoguaranteeten* and *lottoguaranteefifteen*) to represent superdraws when there was a guaranteed jackpot of £15m or £20m.

Our complete Wednesday model, to be estimated by two stage least squares, was therefore:

Stage 1

$$PRICE = \mathrm{f}(\text{constant},\ q^{w(-1)},\ q^{w(-2)},\ q^{w(-3)},\ q^{w(-4)},\ q^{w(-5)},\ Q_s,\ TREND^2,\ WKSSINCEWIN,\ ROLLOVER,\ guaranteeone,\ guaranteefour,\ LOTTOROLLOVER,\ lottoguaranteeten,\ lottoguaranteefifteen) \quad (4)$$

$$PRICELOTTO = \mathrm{f}(\text{constant},\ q^{w(-1)},\ q^{w(-2)},\ q^{w(-3)},\ q^{w(-4)},\ q^{w(-5)},\ Q_s,\ TREND^2,\ WKSSINCEWIN,\ ROLLOVER,\ guaranteeone,\ guaranteefour,\ LOTTOROLL\pm OVER,\ lottoguaranteeten,\ lottoguaranteefifteen)$$

Stage 2

$$q = \mathrm{f}(\text{constant},\ q^{w(-1)},\ q^{w(-2)},\ q^{w(-3)},\ q^{w(-4)},\ q^{w(-5)},\ Q_s, \quad (5)$$

$$TREND^2,\ WKSSINCEWIN,\ EXPPRICE,\ EXPPRICELOTTO) \quad (6)$$

where *EXPPRICE* and *EXPPRICELOTTO* are values predicted for each draw from the results of the first stage equations.

Specification of the Saturday model was similar. A smaller number of lagged dependent variables was included following experimentation, lags of orders four and five proving insignificant. The trend term was initially entered in the form of a quadratic but the squared term was dropped when insignificant. The weeks since a Saturday winner proved to have an effect that was this time captured by including both the number of Saturdays and the square of the number of Saturdays that had passed without a pay out. Instruments were adapted to take account of larger jackpot guarantees, compared with Wednesdays. *guaranteetwenty* accounts for the single occasion when a £20m guaranteed jackpot was advertised for Lotto Extra[12] while *lottoguarantee-fifteen* and *lottoguaranteeoverfifteen* refer to Saturdays when the main Lotto draw had a guaranteed jackpot of either £15m or over £15m (usually £20m).

Summary statistics of key variables, information on which was collected from the archive of lottery statistics maintained at www.merseyworld.com, are presented in Table 1.[13] Results from estimation of the models are exhibited as Tables 2 and 3. As in previous applications of the Gulley-Scott model, there emerges a well-determined downward sloping demand curve and goodness of fit is high. Fortunately, one qualification to the Gulley-Scott model does not apply here. When used to analyse conventional lotto games, the coefficient on *PRICE* in the model is used to measure players' response to improvements in expected value whereas rollovers actually change both expected value and prize structure (in that rollover money influences only the jackpot component of expected value). In Lotto Extra, prize structure was constant since there were no smaller prizes.

Interpretation of the results from our modelling exercise is incorporated in our reflections on what can be learned from the history of this now defunct lottery product.

TABLE 1
SUMMARY STATISTICS

Variable	**observations**	**mean**	**standard dev.**	**minimum**	**maximum**
Wednesday					
Lotto Extra sales (m.)	287	0.695	0.266	0.310	2.055
Lotto Extra 'price'	287	0.611	0.250	−0.360	0.931
Lotto 'price'	295	0.549	0.080	0.165	0.589
Lotto Extra jackpot (£m.)	295	5.466	3.688	1.000	20.102
Weeks with no winner	295	28.708	26.809	0	104
Saturday					
Lotto Extra Sales (m.)	290	0.967	0.422	0.413	3.577
Lotto Extra 'price'	290	0.604	0.255	−0.395	0.932
Lotto 'price'	294	0.522	0.065	0.239	0.563
Lotto Extra jackpot (£m.)	294	5.694	3.806	1.000	21.118
Weeks with no winner	294	10.190	9.439	0	41

TABLE 2
WEDNESDAY MODEL. ESTIMATION BY TWO STAGE LEAST SQUARES

	coefficient	|t|
$q^{w(-1)}$	.1230	3.86
$q^{w(-2)}$	.1166	3.88
$q^{w(-3)}$	.0680	2.19
$q^{w(-4)}$	.0685	2.18
$q^{w(-5)}$	.0809	2.92
Q_s	.1282	6.71
$TREND^2$	−3.68E-06	12.67
WKSSINCEWIN	−.0006	3.43
PRICE	−.5481	25.12
LOTTOPRICE	−.8672	17.93
Constant	8.076	19.71
R^2 (adj.)	.974	
N	243	

Dependent variable: log of sales of Lotto Extra

TABLE 3
SATURDAY MODEL. ESTIMATION BY TWO STAGE LEAST SQUARES

	coefficient	|t|
$q^{s(-1)}$	.2668	6.92
$q^{s(-2)}$	.1018	2.89
$q^{s(-3)}$	.1310	4.51
Q_w	.1455	4.19
TREND	−.0015	13.79
WKSSINCEWIN	.0036	2.26
$WKSSINCEWIN^2$	−.00008	2.07
PRICE	−.4425	17.18
PRICELOTTO	−.8143	12.03
Constant	7.6443	17.67
R^2 (adj.)	.973	
N	267	

Dependent variable: log of sales of Lotto Extra

REFLECTIONS

WHY THE GAME DIED

Any pari mutuel lottery game is a network good. The benefit of participation depends on how many tickets are sold to other players since only if the game is popular will an exciting jackpot be accumulated. This was essentially the point underlying the concept of ‘the peculiar economies of scale of lotto’ introduced to the literature by Cook and Clotfelter (1993).

Given this distinctive characteristic of a lotto product, the long-run prospects of a new game depend heavily on the level of sales in the first few plays. Customers on launch have no record of previous sales to guide them in the decision on how worthwhile the purchase might be (except to the extent that the operator is likely to offer encouragement in the form of a guaranteed jackpot for the first draw). If early sales in fact prove disappointing, some of those who risked buying will conclude that they made a mistake and will abandon the game. For those that remain, the product will now become less attractive and further defections will occur. A vicious circle of falling sales may then result until the game becomes non-sustainable.

This risk must have applied particularly strongly in the case of Lotto Extra. It was targeted at an audience of unknown size that is so interested in the possibility of a very large win that it is willing to forego the bait of smaller prizes altogether. But if the market for such a product turns out to be very limited, not enough prize money can be gathered in the pot to meet the aspirations of this unusual subset of lottery players and the game will therefore wither away.

This seems to be roughly what in fact happened to Lotto Extra. In the first six weeks, notwithstanding that the prize pool rolled over after every single draw, the declared jackpot on Saturday never reached the level of that of the main Lotto game. Early indications were therefore that there were not enough customers to create a network that was self sustaining in the sense that collectively they could put enough in the pot to keep them all individually interested in the product. In such a circumstance, a downward spiral in sales was likely to be triggered and this is what is observed in the results of our estimation. In contrast to most lotto games studied in the past, where trend is positive in the early years before decline eventually sets in (Miers, 1996), trend here is unrelentingly negative. For the Saturday game, the underlying trend was for sales to fall at a constant proportionate rate and the Wednesday data revealed an even more adverse situation, with sales declining at an increasing proportionate rate over time.[14]

SHORT-RUN PRICE ELASTICITY

To be sure, the long sequences of Lotto Extra rollovers produced some attractive looking propositions. On nearly one third of Wednesdays and on one quarter of Saturdays, the Extra game recorded both superior expected value and a higher jackpot than Lotto itself. Draw to draw responsiveness of sales to favourable movements in the mean and skewness of returns was, however, limited and presumably reflected a failure to overcome the resistance of those who give significant weight to variance in returns: this was always high in Extra because of the lack of lesser prizes.

On the basis of our regression results, we calculated short-run own-price elasticity of demand for Lotto Extra. Measured at the mean, it was $-.34$ on

Wednesdays and − .27 for Saturdays, suggesting weak responsiveness to value for money for a gaming product that offers no intermediate prizes. Quiggin (1991) argued that a Friedman-Savage approach to explaining participation in lottery games implies that operators should offer a single, rather than a multiplicity of, prizes. The failure of Lotto Extra to capture a significant part of the UK market suggests that expected utility theory fails to account for the preferences of the bulk of lottery players who eschewed Lotto Extra even when it appeared to offer good value.

LONG-RUN PRICE ELASTICITY

The traditional use to which results from the Gulley-Scott model are put is to assess whether take-out from a game is consistent with net revenue (or profit) maximisation. Whereas short-run elasticity measures responsiveness to better value being offered for a single draw, long-run elasticity is the basis for predicting how sales would change were the lottery to become 'fairer' permanently. It is calculated as short-run elasticity divided by one minus the sum of the coefficients on the lagged dependent variables. Computed here at sample means, the estimated values are − .62 and − .53 respectively, i.e. demand appears to be inelastic with respect to effective price.

The implication is that Camelot would probably not have made the game viable if it had responded to adverse sales by making it more generous to players. On the other hand, while inelastic demand appears to imply that the proportion of revenue used for prizes could safely have been reduced, this may have damaged the reputation of a game the raison d'être of which was to appeal to those who would dream of high jackpots.

CROSS-PRICE ELASTICITY

It is of interest whether Lotto Extra and Lotto were complements or substitutes. When increased value for money was offered to Lotto players, more tickets would be sold and thus there would be more transactions with the option to purchase the add-on Extra product. On the other hand, participants who might normally have purchased one of each could have decided to take two Lotto tickets instead. In fact the former effect dominated since the coefficients on *PRICELOTTO* in the Lotto Extra demand equations were negative and highly significant. Computed at the means, point estimates of short-run cross-price elasticity were − .41 (Wednesday) and − .42 (Saturday). Lotto Extra was much the smaller game, over the period attracting only 3.0% of Wednesday, and 2.3% of Saturday, Lotto sales. As such, it benefited off the back of the big game. The result echoes that of Matheson and Grote (2006) who found positive effects on sales of local state games when the multi-state Powerball offered large jackpots.

WHEN NO ONE WINS

Much attention in the literature on lottery markets focuses on the rationality or otherwise of participants. On the one hand, the Gulley-Scott model invariably yields well defined demand curves, implying that players actively consider value for money when taking decisions, just as with other goods. On the other hand, Guryan and Kearney (2005) document large and long lasting positive effects on sales at stores that sell a jackpot winning ticket even though, objectively, the value of a ticket purchased there has not changed.

Guryan and Kearney place their findings in the context of a literature in psychology and economics that investigates misperceptions of randomness. Our results contribute to the debate by showing an effect, even controlling for expected value (and therefore jackpot, since this is the only source of expected value here), from the number of times the game has been played without producing a winner.

If players take time-consistent decisions based on objective criteria, our variable *WKSSINCEWIN* would be insignificant since the objective odds of winning are unchanged from draw to draw. However, there may be a proportion of players who base their assessment on a mistaken attachment to the gambler's fallacy, reasoning that if there was a winner last week, it's less likely that there will be a winner this week; but, if it's been a while since the jackpot prize was awarded, it must happen soon. The presence of such mythology in the population would lead to a positive coefficient on *WKSSINCEWIN.* However, an opposite emotion may also have an effect: being told draw after draw that no one has won might remind players of how long the odds are in the game and undermine the dream that they might attain fabulous wealth if only they purchased a ticket.

WKSSINCEWIN proved significant in both the Wednesday and Saturday models. But results were not the same in each case. Lower sales on Wednesdays implied very high probabilities of a rollover compared with any other lottery game, and indeed only nine draws out of 295 produced a winner. Long sequences with no money paid out proved very corrosive of support, adding to the underlying downward trend in sales, as illustrated by the strength of the estimated coefficient on *WKSSINCEWIN.*

For Saturdays, the game was more readily won because the market was bigger. A winner was produced on 26 occasions in 294 draws. The pattern captured by our results was that interest picked up as time without a winner passed, up to about week 22, but declined thereafter (42 weeks was the longest gap between Saturday wins). It is tempting to link the first, positive phase to the 'lottomania' claimed by Beenstock and Haitovsky (2001) to be observed in Israel where they found that sales following the third rollover of the lotto game tended to reach levels that could not be explained by the size of jackpot. However, caution should be exercised since explanations other than emotional frenzy may account for their results. In contrast to Lotto Extra, the number of rollovers in the Israeli game was capped at three and the authors' findings may reflect a form of rational intertemporal substitution whereby some players postpone participation until the fourth draw when all prize money is sure to be paid out. But the spirit of our results accords with the overall tone of Beenstock and Haitovsky's paper which is that emotion may partly drive lotto sales and there is scope for insights from psychology to supplement an expected utility approach to understanding the lottery market. But, in any case, our results underline that the emphasis of Clotfelter and Cook (1993) in advising lottery agencies to select game format to ensure reasonable frequency of winners was well taken. While the standard demand modelling approach we have followed here has expected value as a key driver of consumer take-up, facets of game design are also important. It is unlikely that Lotto Extra will serve as a template for those in the future who will seek new avenues for widening operators' portfolios of on-line games.

NOTES

1. By contrast, over one-third of the Lotto prize fund is used on prizes of ten pounds awarded for matching three of the six balls drawn and there are three intermediate tiers below the jackpot.
2. The draw in question was in August, 2004 and offered a jackpot in excess of £21m. The high expected value was associated with sales of 2.26m. Regular Saturday main Lotto draws offer very negative expected returns, yet sales are in the tens of millions.
3. Other lotteries impose such a cap whereby, if there is no jackpot winner after n draws, the jackpot pool is then shared by those matching a lower number of balls in that nth draw. In Lotto, the cap is three, and in Euromillions twelve, draws.
4. See Forrest (2003) for a survey of the literature.
5. Effective price is the nominal price of the ticket (usually one unit of local currency) minus the expected value of prizes for the holder of a ticket.
6. Early applications of Gulley and Scott pooled sales data from midweek and weekend draws, accounting for the lower popularity of the midweek draw by the inclusion of a 'Wednesday dummy'. However, this imposes the implausible constraint, rejected in formal tests, that quantity responds to changes in any exogenous variable, such as expected value, identically as between Wednesday and Saturday. Therefore, current practice is to present separate estimates of Wednesday and Saturday demand and this is followed here.
7. We experimented with different numbers of lags for both the dependent variable and previous Saturday sales. Higher orders of lags than those included here were insignificant.
8. Semi-log was selected in preference to a linear functional form on standard goodness of fit criteria. The choice of functional form is more clear cut than in the case of modelling of lotto because long sequences of rollovers generate a variety of levels of rollover. In standard lotto games, such as UK Lotto, there are only single and double rollovers, creating clusters of observations around three levels of effective price, corresponding to regular, single rollover and double rollover draws.
9. A distinctive feature of the UK lottery is that the operator is permitted to use funds accumulated from earlier regular draws to boost prize money for promotional 'superdraws'.
10. These tiers correspond to matching five balls plus a bonus ball, five balls and four balls respectively. In the unlikely event of there being no second (third) tier winner, the money cascades down to the tier below. The lesser prize money will therefore always be paid out so long as someone matches four balls, which is virtually certain at plausible sales levels.
11. These special draws involved over £0.5m and £3.5m respectively being added to the jackpot once sales were known and therefore had a large influence on *PRICE*. There was a short period when other guarantees were advertised but required only very small amounts of bonus ex post and these are ignored in our Stage 1 specification.
12. This was on May 12, 2001. Sales reached a record 3.58m. With £14m. already rolled in to the prize fund, the final cost to the operator in terms of superdraw money used up was £4.3m. because there was a pay out that day.

13. We sought to analyse data from 295 Wednesdays and 294 Saturdays but sales data were missing for a small number of dates when the £1m. guarantee applied. The presence of lagged terms further reduced sample size in estimation.
14. Though speculatively, one might also link the extremely adverse results on trend to the fact that running a game without minor prizes builds up a group of customers who "nearly" matched six balls and experience regret that they didn't enter their numbers in another lottery game instead. Lotto provides a prize for matching as few as three balls.

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