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## **On the Demand for Lotteries in Greece**

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### **Abstract**

Demand for lotteries has been estimated in several countries, an important issue being whether operators set lottery payouts optimally. The question is tackled by means of a traditional demand equation in effective price and recently by a demand equation variant in jackpots, both specifications indicating that in many countries operators set their payout ratio more or less correctly and slightly on the generous side. The objective of this paper is to provide evidence on the lottery demand parameters in Greece and to assess the optimality of the current payout-allocating rules.

*Key words:* lottery; demand elasticity; payout policy

*JEL classification:* D12; L83

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### **1. Introduction**

Lotto, one of the most popular lotteries, has been actively investigated because it introduces a variation in prizes caused either by varying participation or by rollovers. Although the price of a bet itself does not vary, effective price, or price minus expected payoff, varies considerably because of prize variation. A number of studies have investigated whether lottery operators correctly price their product, in the sense of setting revenue maximizing payout ratios in line with the inverse elasticity rule (Cook and Clotfelter, 1993; Farrell et al., 1999; Forrest et al., 2002; Gulley and Scott, 1993; Mason et al., 1997). It must be noted that in the present context “pricing” refers to effective rather than face ticket prices and that assessment of current “pricing” refers to the payout component of the effective price.

In standard analysis, payout rules are correctly set in a lottery if its effective price elasticity is equal to unity in absolute value, implying that the operator’s net

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revenue is maximized. Recently, however, Forrest et al. (2002) analyzed the issue of optimality directly by focusing on the jackpot elasticity of demand. Their approach has still a straightforward implication for optimal parameter setting in the sense that if the jackpot elasticity of demand is equal to the payout ratio, then net revenue is maximized. Optimality can therefore be attained by adjusting the payout ratio to the elasticity of demand.

This paper analyzes payout-allocating rules in the Greek lottery and assesses their optimality. Demand equations both in effective price and jackpot are estimated, and corresponding point elasticities are calculated on the basis of the time series of JOKER, a lotto game recently introduced in Greece. Elasticities are then used to assess the payout-allocating rules set by the local operator. The evidence presented in this paper suggests that the local operator has set a payout ratio lower than what would have been optimal given the lottery demand parameters in Greece.

The rest of the paper is structured as follows. The lottery is described in Section 2, methodology and results are presented and discussed in Section 3, and conclusions are drawn in the final section.

## 2. The Game

JOKER was launched in November 1997. The game consisted in selecting 5 numbers out of 45 plus one bonus number out of 20, and the odds of winning the jackpot were 24,435,180 to one. There were eight prize categories, the jackpot for those having predicted the correct 5+1 numbers drawn, and seven lesser categories for 5, 4+1, 4, 3+1, 3, 2+1, and 1+1 correct numbers. The overall payout ratio was set to 50% of sales with 20% to the jackpot, 9% to the second prize, and 21% to the other prizes. A minimum jackpot was guaranteed. There were two draws per week from the start, undistributed prizes were rolled over to the next draw, and a bet's price was set equal to \$0.42 (€0.29) (for a US/€ rate of 1.4609 on Jan. 18, 2008).

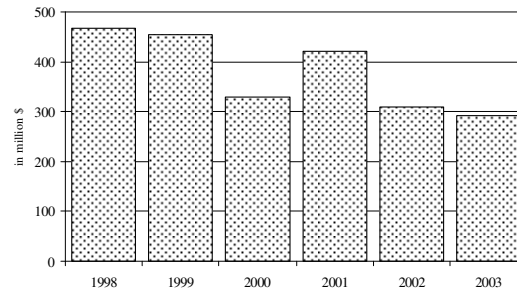
The JOKER was an exceptional success. Sales in 1998, its first full year of existence, exceeded \$438,270 million (€300 million), and success continued in subsequent years; see Figure 1.

## 3. Demand Estimation

Empirical analysis is based on the estimation of the demand parameters and the point elasticity of demand. The corresponding demand equations with respect to effective price and jackpot are:

$$\begin{aligned}
 P &= \alpha_0 + \alpha_1 \ln Q_{-1} + \alpha_2 R + \alpha_3 R^2 + \alpha_4 T + \alpha_5 T^2 + \alpha_6 D + v \\
 \ln Q &= \beta_0 + \beta_1 \ln Q_{-1} + \beta_2 \hat{P} + \beta_3 T + \beta_4 T^2 + \beta_5 D + u
 \end{aligned}
 \tag{1}$$

Figure 1. Annual JOKER Sales



for the effective price model specification and:

$$\begin{aligned}
 J &= \gamma_0 + \gamma_1 \ln S_{-1} + \gamma_2 R + \gamma_3 R^2 + \gamma_4 T + \gamma_5 T^2 + \gamma_6 D + v \\
 \ln S &= \delta_0 + \delta_1 \ln S_{-1} + \delta_2 \hat{J} + \delta_3 T + \delta_4 T^2 + \delta_5 D + u
 \end{aligned}
 \tag{2}$$

for the jackpot model specification where:

- $Q (\neq S)$  is bets (not equal to sales because of a non-unitary price)
- $Q_{-1} (S_{-1})$  is lagged bets (sales)
- $P$  is the effective price
- $J$  is the jackpot
- $T$  is the trend
- $D$  is a superdraw dummy
- $u$  and  $v$  are error terms
- $R$  is the jackpot rolled over from the previous draw

and hats denote fitted values. Sales were substituted for bets because lotto in Greece did not have a unit price, and estimation was performed with two-stage least squares (2SLS) because bets (sales) and effective prices or jackpots are simultaneously determined. Squares of rollover and trend were included to capture potential nonlinear effects.

The effective price,  $P$ , of a bet was calculated using the standard formula:

$$P = C - (\text{expected prize}) \times (\text{expected share}), \tag{3}$$

where  $C$  is the face value of a bet. Assuming that lottery tickets are submitted randomly and independently, the number of winning bets is well approximated by the Poisson distribution, and expected share is given by  $(1 - e^{-pQ})/pQ$  (Cook and Clotfelter, 1993, p. 636). On the other hand, expected prize is equal to the current draw's jackpot,  $J$ , plus any rollover,  $R$ , from previous draws times the probability,  $p$ , of a bet winning the first prize, so that:

$$P = C - p(R+J) \frac{1-e^{-pQ}}{pQ} = C - \frac{(R+J)(1-e^{-pQ})}{Q}. \quad (4)$$

Point elasticity estimates corresponding to specifications (1) and (2) are given by  $\hat{\beta}_2 \bar{P}$  and  $\hat{\delta}_2 \bar{J}$ , where bars denote sample averages, and optimality of the payout parameter decision is inferred by testing the null hypotheses  $H_0: \hat{\beta}_2 \bar{P} = -1$  and  $H_0: \hat{\delta}_2 \bar{J} = j$ , where  $j$  is the payout ratio for the first category prize.

Data on JOKER sales, prizes, and number of winning tickets per draw were collected from the operator's website (www.opap.gr) and cover the period from July 1999 to December 2003. Results are reported in Table 1.

**Table 1. JOKER Demand Equation**

	Model (1)	Model (2)
Constant	13.879 (16.204)**	11.994 (23.055)**
Lagged Bets	0.237 (4.401)**	—
Lagged Sales	—	0.162 (4.542)**
Trend	$-2.073 \times 10^{-4}$ (0.618)	$-3.395 \times 10^{-4}$ (1.182)
Square Trend	$-7.836 \times 10^{-7}$ (1.074)	$-4.191 \times 10^{-7}$ (0.663)
Price	-7.185 (13.644)**	—
Jackpot	—	$2.072 \times 10^{-7}$ (17.911)**
Superdraw	-0.453 (1.816)	-0.364 (1.692)
Short-run elasticity [99% CI]	-1.729 [-2.055, -1.402]	0.305 [0.261, 0.349]
Adjusted R <sup>2</sup>	0.63	0.73
Durbin $h$	1.97	1.95
Sample size	467	467

Notes: Absolute values of t-statistics in parentheses. \*\* and \* denote significance at 1% and 5% levels.

Inspection of Table 1 indicates that JOKER was designed in a rather parsimonious way, and payouts were set lower than what would have been justified by net revenue maximization. The effective price elasticity estimate from model (1) is -1.73, which is significantly greater than unity in absolute value at the actual payout of the game, and the jackpot elasticity estimate from model (2) is approximately 30%. Superdraws seem not to have elicited significant response as compared to rollovers, lagged bets and sales; the superdraw dummy coefficient is not significant in either model at standard significance levels. Finally, the trend and square trend coefficients appear to be insignificant.

We find that price elasticity was extremely high in Greece as compared to other lotteries. For instance, Gulley and Scott (1993) reported price elasticities of -1.15, -1.92, and -1.20 for the Massachusetts, Kentucky, and Ohio lotteries, Farrell et al. (1999) found a short-run price elasticity of -1.05 for the UK National Lottery, whereas Forrest et al. (2002) estimated a short run elasticity of -0.82 and -0.84 on a more recent set of data for midweek and weekend draws of the British lottery.

Although price sensitivity is measured in response to transitory effective price changes (caused by rollovers as well as superdraws), one would be inclined to expect that a more generous design in terms of payouts would be advisable.

#### 4. Conclusions

Lottery demand elasticity in Greece appears to be much higher than its revenue maximizing value. Our findings suggest that the game is “overpriced” as compared to lotteries in other countries in the sense that the payout is set too low by the Greek provider. In our opinion and in view of our estimates, the Greek provider should consider a more generous payout in order to stimulate greater lottery revenues.

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