

COMPLEMENTARITY AND SUBSTITUTION BETWEEN SIMILAR GAMBLING PRODUCTS IN SOUTH AFRICA

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ABSTRACT

In line with the liberalisation of gambling laws across many countries of the world, the lottery and other gambling revenues increasingly feature prominently in many countries' public finance planning. Apart from being a voluntary tax levied by the government, it is economical to administer, minimal to no compliance and enforcement are required and, most importantly, citizens pay it with a smile. It is also regarded as a precursor to future models of taxation where incentives can be used to sweeten citizens' appetite to voluntarily pay tax. In the South African context Uthingo was contracted and mandated by government to run the lottery with a view to maximising revenue for good causes. In the effort to increase revenue, the lottery operator introduced a few games; this research seeks to quantify the extent to which these additional games are complements to or substitutes of the original game.

The research is broken down into three periods. During the first period (2000/03/01–2001/09/29), only weekly draws were conducted on Saturdays; total revenue of R51 Million was collected per week. During the second period (2001/10/03–2003/11/22), the game frequency was increased from only Saturday to include an additional Wednesday draw; total revenue increased to R81 Million per week. During the third and last period (2003/11/26–2007/03/31), both Lotto and LottoPlus games were offered on Saturday and Wednesday, but the total revenue per week from both games plummeted by R3 Million to R78 Million.

Using regression analysis with the aid of StatPro, in the first period the research found no substitutes; the complements were Sales from four weeks previously and the Sales immediately before the current draw. Furthermore, one of the two methods used showed an upward sloping demand curve while the second method showed a small drop in effective price resulting in disproportionate increase in revenue. In the second period, Sales conducted on the same day of the week as the current draw were found to be complements, whereas for the Sales on different day, the immediately past is statistically insignificant and the one before that is a substitute. For the third period, the only statistical significant

complements are the sale of the current LottoPlus, immediate past Lotto and LottoPlus Sales. The substitutes were the Lotto and LottoPlus draws four draws ago.

The research concludes that the board did things right but not the right things: the lottery board construed their mandate to maximise revenue too narrowly and subsequently targeted their games to the general population, which in the lottery context implies the poor and vulnerable. The board should have interpreted the mandate by the need to collect maximum revenue from the rich with a view to distribute to the poor. Recommendations are made on how the board could target the wealthy and affluent in their endeavours.

DECLARATION

I declare that this research report is my own, unaided work. It is being submitted in partial fulfilment of the requirements for the degree of Masters of Business Administration in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

Friday Mongwe

____ day of _____ 2009.

DEDICATION

I dedicate this research to the three women in my life, my wife Antoinette Mongwe, my mother Miluva Mongwe, and my Grandmother Nkiyasi Mhlongo, to all my siblings and my son, Shihluke Mongwe. Thanks for your support, guidance and most importantly, for putting up with me.

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GLOSSARY

- African National Congress (ANC) - a liberation movement which became the ruling political party in South Africa since the 1994 general elections.
- *Ceteris paribus* is a Latin phrase, literally translated as "with other things being the same," meaning "all other things being equal".
- Effective price of the lottery – the price of the ticket that is linked to the prospective prize money.
- FNB – First National bank, one of the big four banks in South Africa.
- Freedom Charter – a most sacred document within the ANC led tripartite alliance which sets out the vision of the post apartheid South Africa, it was adopted at the Congress of the People, Kliptown, on 26 June 1955.
- Giffen good is one which people consume more of as price rises, thus violating the law of demand. In the Giffen good situation, cheaper close substitutes of what may be considered an essential good are not available, and more expensive substitutes are less affordable. Because of the lack of substitutes, the income effect dominates, with people buying more of the good even as its price rises.
- Government shall refer to the SA government.
- Law of demand – a microeconomic law that postulates that, all other factors being equal, as the price of a good or service increases, consumer demand for the good or service will decrease and vice versa.
- Lotto or lottery - refers to a game where players select a small group of numbers (usually six) from a large set (usually 49) and are awarded prizes based on how many match the randomly drawn result.
- LottoPlus - an extension of Lotto in which selections made for a Lotto draw are wagered for an additional corresponding LottoPlus draw at an

additional cost of R1.50 per board.

- Nominal Price of the lottery - the price of one ticket, which stands at R2,50 at the time of writing this report.
- Period 1 - Refers to the period between 2000/03/01 and 2001/09/29 when the lottery was offered only on Saturday.
- Period 2 - Covers the period between 20001/10/03 and 2003/11/22 when the lottery was offered on Saturday and Wednesday.
- Period 3 - This is the period between 2003/11/26 and 2007/03/30 when both the Lotto and LottoPlus lotteries were offered on Saturday and Wednesday.
- Uthingo shall mean the previous licensed lottery operator.
- Parimutuel or Pari-mutuel - A method of payout that splits the total available money between all winners at a particular prize level.
- Payout - This is the cash prize given to a player who holds the winning combination of numbers.
- Rollover - An event that occurs when the lottery jackpot or a jackpot game is not won. The jackpot thus 'rolls over' to the next draw. The rollover amount is also called the rollover.
- Vodacom – South Africa's largest mobile network and services provider.
- Veblen goods are a theoretical group of commodities for which peoples' preference for buying them *increases* as a direct function of their price, as a consequence of snob effect (a perception of high status creates a desire to own unusual, expensive or unique goods), or network effects (or bandwagon effects) in which preference for a good increases as the number of people buying the same increases.

1 INTRODUCTION

In line with the liberalisation of gambling laws across many countries of the world, there is an increasing need for a study into gambling's most important factor - its economics. As a result there has been a flurry of literature on gambling economics and gambling product marketing. Apart from being a voluntary tax levied by the government, it is cheaper to administer, compliance enforcement is not required, and, most importantly, citizens pay it with a smile. It is also regarded as a precursor to future models of taxation where incentives can be used to sweeten citizens' appetite to voluntarily pay tax.

One of the popular sub topics post deregulation is the impact of lotteries and casinos on traditional forms of gambling such as horse racing. *Ceteris paribus*, consumers benefit from new products introduced to the marketplace due to increased choice, product substitution and the resultant price reduction. For the suppliers, on the other hand, that translates to reduced sales for the original product offering.

This study aims to develop an empirical model to assess the extent to which similar gambling products divert sales from each other in keeping with Porter (1996, p.76) who advises to guard against *"compromises and inconsistencies in the pursuit of growth [which] will erode the competitive advantage a company had with its original [product] varieties or target customers"*. This study focuses on the Saturday lottery, the Wednesday lottery, and their lottery plus counterparts, to assess the extent to which the sale of each product diverts sales from the other three similar gambling products.

1.1 Purpose of the study

The South African lottery went through three stages: when only weekly Saturday draws were conducted; when bi-weekly Lotto sales were introduced a couple of years later, on Saturday and Wednesday; and the third stage, when biweekly LottoPlus was introduced. Considering these new products were aimed at the same market segment using the same distribution channels, this study aims to quantify the extent to which the sales of the different products complement or cannibalise each other's sales.

The issue of substitution among lottery games is well documented in literature. Clotfelter and Cook (1989) tested the effects of introducing lotto games on the sales of scratch-card tickets. Stover (1990) finds significant substitution effects between lotteries run by contiguous states. Gulley and Scott (1993) looked at whether the two state lotto games in Massachusetts serve as substitutes for one another, finding no significant relationship between the two.

Forrest, Gully and Simmons (2004) found evidence of some substitution among the variety of games offered by the United Kingdom National Lottery. Grote and Matheson (2006) also found that the introduction of a multi-state game reduces sales in an existing state lotto game but that the newly generated sales of the multi-state game exceeded the loss of sales in the state game in all three of the cases studied.

1.2 Context of the study

According to Clotfelter and Cook (1993), state lotteries can be evaluated in one of two perspectives: as a source of public revenue or as a consumer commodity. As a source of public revenue former New Hampshire director, Edward Powers (1983), summed it up when he said *“The lottery agency should be treated like a business...this is the only way to maximise revenues”*. Michigan law (Michigan 1985, as cited in Clotfelter and Cook 1990) states that *“the lottery shall produce maximum amount of net revenues for the state consonant with general welfare of the people”*. The South African National lottery board (NLB 2002) also concurs when it said in a press release that Uthingo (the previous lottery operator)’s objective is *“... to generate funds from games such as ScratchCards and LOTTO and to maximise the revenue for Good Causes”*. Bourie (2000) refers to gambling as a form of entertainment with an ingenious billing system.

The lottery’s only public virtue is revenue generation, and in an effort achieve this objective the lottery board first introduced the lottery with weekly Saturday night draws, followed by an additional Wednesday draw. The bi-weekly draw initiative was conceived as a strategy to increase sales by targeting existing lotto consumers using the same distribution channels and branding to increase their frequency of consumption (market penetration strategy). Most recently the lotto plus game was introduced for both Saturday and Wednesday draws; the Lotto and LottoPlus products are essentially similar products

serving the same target market and are aimed at increasing the variety of the offering (product line extension).

This strategy has been shown to be precarious. Studies have demonstrated that between 30–35% of new products fail (Crawford 1979, Booz Allen Hamilton 1982), a study by Association of National Advertisers (ANA 1984) found that 27% of product line extensions fail, Bragg (1986) painted a much gloomier picture with a disturbing 20% figure. Even though product extensions are not classified as failures, they may cannibalise sales of existing products and dilute the image of the original brand over time (Economist 1990).

1.3 Problem statement

1.3.1 Main problem

The purpose of the research is to develop a quantitative model describing the extent to which similar lottery gambling products complement or cannibalise each other's sales.

1.3.2 Sub-problems

The outcome of this research will be a quantitative model that will answer the following sub problems:

- The extent to which *same week* (Saturday and Wednesday) Lotto draws are complements to or substitutes of each other.
- The extent to which *same day* Lotto and LottoPlus draws are complements or substitutes of each other.
- The extent to which the previous four draws affect current sales.

As a by product of the research, the model will also answer the following questions:

- The extent to which Timing (week in a month) affects the Lotto and Lotto Plus sales.
- Extent to which the Trend (which *encompasses both fatigue and advertising spend*) affects the Sales.
- The extent to which taking into account people's willingness to participate in an unfair bet improves the traditional model's result.

1.4 Significance of the study

According to Nancy Bauer the president of Bauer and Rosner (Bragg 1986, p. 61), "Line extension products now outnumber new product launches four to one". A survey (Aaker 1991, p. 208) found "89% of new product introductions were product line extensions (new flavour or package size), 6% were brand extensions, and only 5% were new brands". Fillman (1999) also found that less than 6% of the "new" products introduced featured any innovation in technology, formulation or market creation. It is necessary to study product line extensions as these are by far the most dominant way of introducing new products into the market (Bhat et al. 1994).

Gambling revenues continue to form a significant part of any government's fiscal planning, partly due to their high yield, voluntary nature and considerably lower enforcement costs. The substitutability and complementarity of different gambling products is an important consideration for any jurisdiction contemplating (or engaging in) deregulation of its gambling sector. While there is a considerable amount of research on gambling and its assortment of variation, lately the lottery has also started to gain its proportionate share of attention, most of which centres on the lottery as a form of government revenue or its social impact on society. One of those studies was undertaken by the National Gambling Board (figure 1, after National Responsible Gambling Programme (NRGP) 2006) which showed significant increases in lottery uptake and in participation against the backdrop of an overall decline in gambling statistics in South Africa between 2001 and 2005 for the other games.

The national gambling board study further showed an increase in the number of people who play only the lottery, from 41.4% in 2003 to 52.5% in 2005. It also showed a

decrease in number of people who never gamble, from 20.1% in 2003 to 15% in 2005. The study goes on to conclude that growth in the gambling industry comes principally from the lottery. This study focused on substitution among similar lottery gambling products as it represents by far the most prominent and fastest growing form of gambling in South Africa.

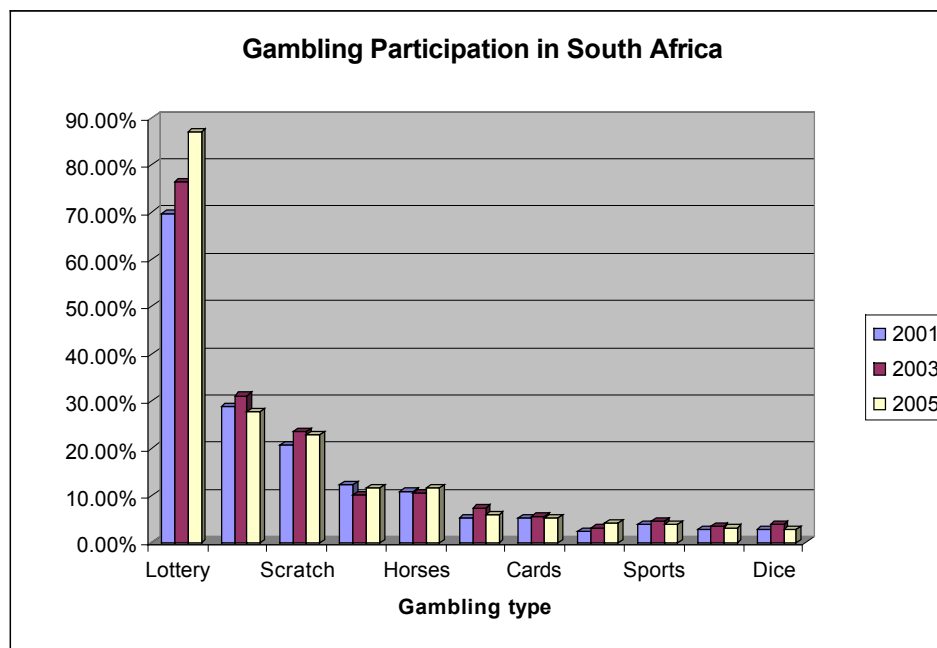


Figure 1. Gambling Participation in South Africa (data from NRGP 2006)

While most of prior lottery studies were confined to the UK and US lottery data, due to a sizeable differences in average disposable income of these countries and the developing world which is acknowledged as a major contributor to the elasticity of demand, these studies will not be representative of the South African and indeed other developing countries. This study is a first in Africa and one of the few in developing countries whose finding can be contrasted with those from the developed world to confirm or rebut or reveal limitations (if any) of the earlier studies.

Tein et al. (2006) recently attempted to enhance the traditional empirical model to account for bettors' willingness to participate in an unfair bet, and their results showed a much improved statistical fit than compared to the traditional established model. Significantly, their study was performed in Taiwan (unlike other studies that were done in first world countries). This study (using the South African data) will serve as a

confirmation of their results in an almost similar setting by using both the traditional and their unfair bet proposition.

While this study used historical results whose relevance can be questioned going forward, akin to driving through the rear view mirror, Burger et al. (1981), Hogarth and Makridakis (1981) and Assumus (1984) correctly point out that, in a quest to improve product performance, product forecasting prior to introduction into the market is as important as the feedback after customers have interacted with the product. The results could prove valuable to the recently-announced lottery operator when introducing new products.

1.5 Delimitations of the study

The research was limited to the period up to 2007/03/31, at which time the first licensee's operating licence expired. A new operator brought in new sets of machines, a new operating partner, etc., which would have distorted the results somewhat going forward. The bonus ball was considered for the purposes of this study in so far as prize allocation is concerned, consistent with some of the preceding research, thus making comparisons easier; in other words, predicting 4 numbers and predicting 4 numbers plus the bonus ball correctly are treated as separate categories for the purposes of this study.

This study was limited to the internal sources of cannibalisation as these are within management's jurisdiction, line of sight and control.

1.6 Assumptions

The following assumptions will be made in this study:

- The information supplied by the lottery board and Uthingo is assumed to be correct. This draw statistics information includes, but is not limited to, number of participants, winners in each category and the associated prize monies for each draw. This information is deemed to be a true reflection of events.
- The ratio of foreign participation in the South African lottery is so insignificant that it is deemed to be consumed exclusively by South African residents.

2 LITERATURE REVIEW

2.1 Introduction

Prior to the 1994 democratic dispensation, gambling (*with the exception of horse racing*) has been illegal in South Africa. After the elections in 1994, the new government recognised the existence of an unstimulated demand for gambling in South Africa, and saw its role as that of regulating the supply to satisfy this demand. Consequently the Howard Commission was appointed with a view to informing the government policy on gambling matters, which led to the formation of Lotteries and Gambling Boards. Apart from regulating the industry to ensure the poor and destitute ultimately benefit, the gambling industry was also identified as one of the industries where Black Economic Empowerment (BEE) could be vigorously promoted.

Three organisations perform various roles in running the National Lottery: the National Lotteries Board which oversees the lottery in terms of the Lotteries Act (Republic of South Africa (RSA) 1997), the majority black owned and ran Uthingo and now Gidani, the previous and current licensed operators respectively, and Distribution Agencies (reporting to the National lottery board) which are responsible for the identification and distribution of the lottery proceeds to good causes.

There are 13 main functions of the lottery board as described in the Lotteries Act (RSA 1997), which include the following among others:

- To maximise the sales realised by the National Lottery;
- To protect the interests of *all* participants;
- To ensure that lottery is conducted with due propriety;
- To ensure that a percentage of money from ticket sales is transferred to the National Lottery Distribution Trust Fund and is administered and invested in terms of the Lotteries Act.

2.2 Introducing the lottery game.

In a lottery game, usually a machine is used to select n random numbers from a pool of N , the most popular version being the Lotto6/49 where 6 numbers are selected from a total of 49; this is the version played in South Africa. Six winning numbers are drawn one at a time without replacement from the selected machine. The order in which the first six numbers are drawn is not significant as long as between 3 and 6 of the numbers are drawn, the player wins. In addition to the six numbers drawn, a seventh ball is also drawn, called the bonus ball, which entitles the player to a bonus if selected with at least three correct numbers. For a more detailed introduction to the lotto 6/49, the booklet by Ziemba (1986) gives fitting and engaging introduction and responds to number of frequently asked questions on the lottery.

2.3 Lottery and network externalities.

Over the years a numbers of mathematical models where developed to forecast the product diffusion process, the most prominent are shown in figure 2 below:

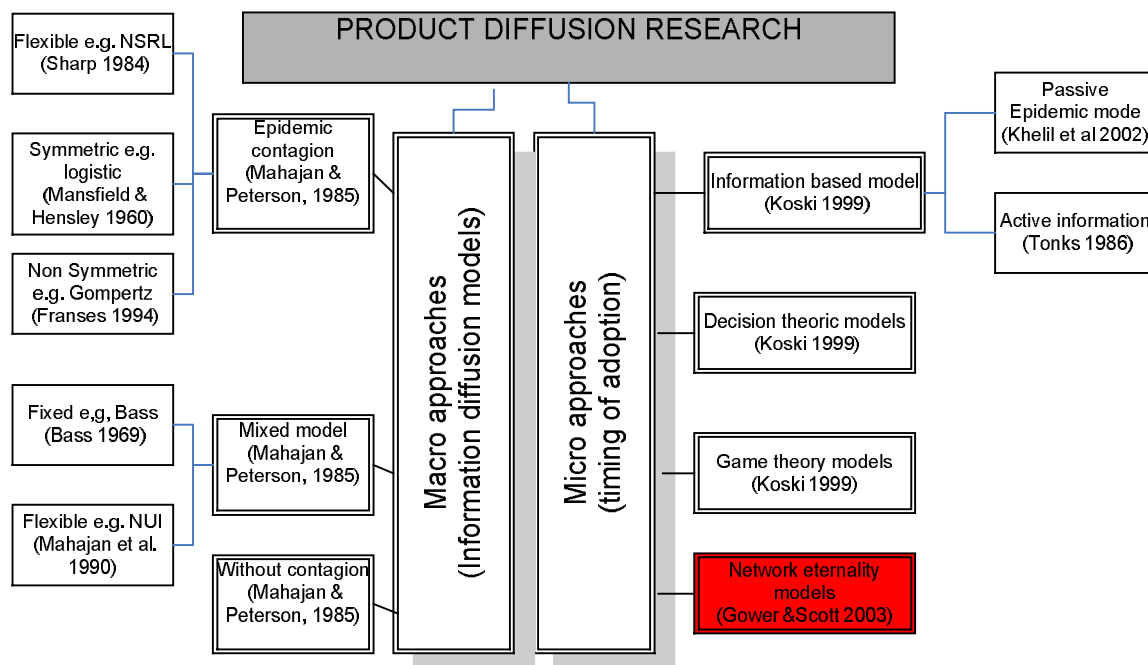


Figure 2 Product diffusion research in economics (adapted from Frank 2000)

For the purpose of this study, the focus on the Network Externality models, which seek to explain a unique phenomenon: unlike most private goods where the voluntary exchange of goods or services is mutually and exclusively beneficial to both seller and buyers, the exchange for goods exhibiting network externality can result in unintended consequences, beneficial or detrimental to third parties.

- The network externalities cause a good or service to have a value to a potential customer dependent on the number of customers already owning that good or using that service (Katz and Shapiro 1986, Farrell and Saloner 1987, Katz and Shapiro 1994; Gower and Scott 2001). A single fax machine is useless, but the value of every fax machine increases with the total number of fax machines in the network, because the total number of people with whom you may send and receive documents increases. Katz and Shapiro (1985) defined these as direct network effects and Schoder (2000) classified these as demand side externalities.
- Availability of and competition between complementary products also increases the value of the good or services, which is referred to variously as indirect network effects (Katz and Shapiro, 1985) or supply side externalities (Schoder 2000).

Furthermore, contrary to conventional economics' downward sloping demand curve which postulates that demand for a good will always decrease with increasing price, several empirical studies disproved this theory in industries which exhibit network externalities, as has been demonstrated in the case of spreadsheet software (Gandal 1994, Brynjolfsson and Kemerer 1996), video cassette recorders (Park 2003), telecommunication (Economides and Himmelberg 1995, Augereau et al. 2003, Forman and Chen 2003), banking networks (Saloner and Shepard 1995, Kauffman et al. 2000), and consumer electronics equipment (Dranove and Gandal 2003, Goolsbee and Klenow 2003, Gandal et al. 2000).

As shown in Ciecka et al. (1996), the peculiar nature of the lottery is such that there exists a point at which an additional ticket purchase increases everyone's expected value (positive externality in the form of higher prize money), while in another case, the very same additional purchase reduces this expected value (a negative externality when most of the prizes are shared by large numbers of winners). The value of the lottery to the

player increases or reduces in the case of positive or negative externality respectively and future sales figures are affected accordingly.

2.4 National Lottery growth strategy

Lotteries the world over conform to one basic model, they are government owned monopolies with exclusive operating rights (enshrined in legislation and jealously guarded) designed to thwart potential competition. The lottery rules are such that at least 50% of the generated revenues are not returned as prize money, and a private operator is usually licensed to run the lottery, away from the politics, inefficiencies, unionism and bureaucracy that characterise most government departments and parastatals. If there was ever any doubt, the South African lottery board was very clear when outlining its strategy as seeking to maximise revenue (National Lottery Board (NLB) 2002) consistent with other lotteries abroad (Powers 1983).

In order to maximise or increase revenues, Ansoff (1965) proposes 4 distinct growth strategies:

- Diversification – this usually involves using a strong brand to enter new markets with new products, a strategy championed by the Virgin group of companies.

Table 1 Ansoff growth matrix

		Products	
		Current	New
Markets	Current	Market penetration	Product development
	New	Market development	Diversification

Source: Ansoff (1965).

- Market development - occurs when an established product is tweaked to target a different market segment, such as low cost airlines targeting traditional road customers.

- Product development - occurs when a firm introduces new products with the aim of stimulating sales from current market. Product development can be achieved by new product development, product replacement, product reformulation, product quality improvements, product feature additions and product line extension (Varadarajan 1986).
- Market penetration - occurs when a company enters/penetrates a market with current products. The objective being either winning part of the competitor's market share, attracting previous non users of one's product or increasing consumption / purchase rate of current users.

The national lottery used a two-pronged strategy in its quest to increase sales, firstly with the market penetration strategy to increase the number of times the lottery is played (frequency of consumption) from once a week to bi-weekly Saturday and Wednesday draws. Secondly a product development strategy took the form of a product line extension when the LottoPlus was introduced.

2.5 Product line Extension.

Product line extension refers to an introduction of a similar version of an existing product in the same segment of the target market to increase the variety of an offering, thus leveraging on existing brand loyalty and awareness because consumers are more likely to buy a new product that has an established and reputable brand name on it. Researchers have examined how attitudes toward an extension are shaped by attitudes or other associations with the parent brand (MacInnis and Nakamoto 1991). Certain scholars looked at the fit between the extension and the parent brand (Aaker and Keller 1990, Chakravarti et al. 1990, Park et al. 1990), while others (Boush et al. 1987, Aaker and Keller 1990, Herr et al. 1990, Boush and Loken 1991) confined themselves to the interaction of the original product and the extension.

As outlined in Bhat et al. (1994), it is imperative for management to know what contributes to the success of the product line extension strategy, as it makes up about 89% of new product introduction activity. Among others their study findings demonstrated:

- Line extensions of strong brands are more successful than extensions of weak brands.
- Line extensions that receive strong advertising and promotional support are more successful than those extensions that receive meagre support.
- Line extensions entering earlier into a product subcategory are more successful than extensions entering later, but only if they are extensions of strong brands.
- Firm size and marketing competencies also play a part in an extension's success.
- Earlier line extensions have helped in the market expansion of the parent brand.
- Incremental sales generated by line extensions may more than compensate for the loss in sales due to cannibalisation.

2.6 Product Cannibalisation.

Product cannibalisation is defined as “the process by which a new product gains sales by diverting sales from an existing product” (Harvey and Kerin 1979, Heskett 1976) and as “the extent to which one product’s sales are at the expense of other products offered by the same firm” (Copulsky 1976, Mason and Milne 1994). Ehrenberg (1991) asserts that any new product entering a market will take market share from all the existing players, and while acknowledging the importance of and difficulty in predicting these cannibalisation effects, ignoring them may have adverse consequences on the financial performance of a company (Harvey and Kerin 1979, Chen and Yu 2001).

Lomax (1996) stated that the risk of cannibalisation is a real threat for many new product introductions, and that the risk becomes more significant if the new product is launched under the same brand name as an existing product, such as the lottery games were.

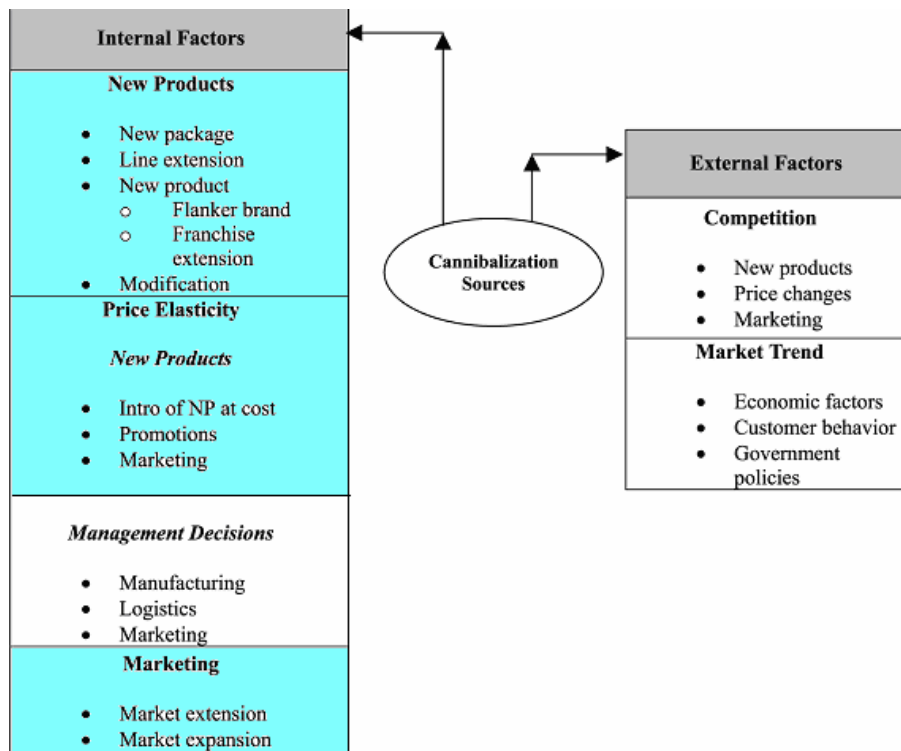


Figure 3 Sources of product cannibalisation: Srinivasan et al. (2003)

Srinivasan et al. (2003) identified the different sources of cannibalisation shown in figure 3 above. Three of the four factors are relevant to this study, namely:

- Product line extension among other ways of introducing new products.
- Price elasticity which could be caused by price changes brought about by an introduction of a new product.
- Marketing policies such as an introduction of a new product into a market where the firm already has a presence in the form of a product.

This study was limited to the internal sources of cannibalisation as these are within management's jurisdiction and line of sight.

2.7 Effective Price of the Lottery game.

Although the nominal price paid for a lottery ticket remained the same at R2.50 for the period of this study, what the bettor was purchasing was the prospective prize money. If the rules of the game result in a reduction in the prize money, e.g., when more people win the jackpot and the prize has to be shared, the effective price of the ticket has

increased, and the opposite is true when fewer bettors win. The most popular empirical model for lotto demand is the 'effective price' approach (Clotfelter and Cook 1993, Gulley and Scott 1993, Gulley and Scott 1995, Walker 1998, Farrell et al. 1999a, Purfield and Waldron 1999, Forrest et al. 2000). The effective price of a ticket is equivalent to nominal price minus the expected value of the bet's payoffs.

$$\text{Effective Price} = \text{TicketPrice} - \left(\frac{(R + jQ)(1 - e^{-Qp})}{Q} + EV_s \right) \quad (\text{eq. 1})$$

Where:

Eq. = Equation.

R= Amount added to the draw by the rollover or adhoc increases to the jackpot.

j = The proportion of revenue allocated to the jackpot

Q = Total Sales in Rands for that draw

p = probability of winning the jackpot = $\frac{1}{\binom{49}{6}}$ for Lotto 6/49

EV_s = expected value of smaller prizes

The above equation includes an expression for an Expected Value (EV) of the jackpot used by Clotfelter and Cook (1993) which requires bettors to choose their numbers randomly. However, evidence from the US lottery (Scoggins 1995) and the UK lotteries (Moore 1997, Farrell et al. 2000a) showed bettor selection to be non random. Farrell et al. (2000a) while acknowledging the non randomness, also showed however that this conscious selection has negligible effect on the price elasticity of demand for the lottery.

2.8 Evaluating Elasticity of demand for the lottery

Tempting as it is to use a simple regression model of Effective Price versus Sales, it has been shown in literature to be an injudicious decision for two main reasons:

- It has been shown (Forrest et al. 2000a, Forest et al. 2002) that effective price will not be exogenous as it depends on how many tickets were sold (*see equation 2*).
- The effective price calculated, while mathematically and logically sound, is not what the bettors would have considered when making the purchase decision; the

exact value is only appraisable post-ante (Gully and Scott 1993, Forrest et al. 2000b, Forest et al. 2002).

Since the effective price cannot be observed ex ante, Forrest (2002) and most scholars use a two stage regression model to evaluate the elasticity of demand for the lottery, hereafter referred to as model 1. In the first stage, some observable variables, such as occurrence and the size of rollovers, are used as instruments to determine the effective price. In the second stage, demand for lotto is regressed on the effective price estimated in the first stage.

Stage 1:

$$\text{Effective Price} = f(\text{Sales}_{t-1}, \text{Superdraw}, \text{Rollover}, \text{RolloverSquare}, \text{Trend}, \text{TrendSquare}, \text{Weekday}) \quad (\text{eq. 2})$$

Stage 2:

$$\text{Sales}_t = g(\overline{\text{Price}}, \text{Sales}_{t-1}, \text{Sales}_{t-2}, \text{Sales}_{t-3}, \text{Sales}_{t-4}, \text{Superdraw}, \text{Rollover}, \text{Trend}, \text{TrendSq}, \text{Day}) \quad (\text{eq. 3})$$

Where:

Eq. = Equation.

Effective price = Price of ticket - the expected value of prize receipt (EV).

$\overline{\text{Price}}$ = Is the effective price estimated from the first-stage regression.

Sales_t = The number of the tickets sold;

Sales_{t-n} = Lagged n-period sales, which are included to capture persistence in sales.

Rollover = Amount carried over (not won) from the immediately preceding draw and added to the jackpot pool in the current draw.

Superdraw = dummy variable that takes value one for a specific draw when the National lottery pre-announced to top-up the current jackpot.

Trend = sequence of lotto period.

TrendSq = square of Trend.

Day = dummy variable that takes value 1 for Saturday draw and 0 for Wednesday. This dummy is included to be consistent with Forrest et al. (2000b), whose UK lotto data exhibit different patterns depending on the draw date, Wednesday or Saturday.

While intuitively ex post and ex ante ticket sales may differ if players inaccurately estimate ticket sales, research (Scott and Gulley 1995, Matheson and Grote 2003) has shown that the results approximately match each other for a large number of drawings. This is what is they defined as the equilibrium stage.

2.9 Why do bettors accept an unfair bets

There are many theoretical models in literature that seek to explain why bettors accept unfair odds despite being risk averse, e.g., gamblers accepting negative expected returns for the lottery, while at the same time purchasing insurance for other aspects of their lives. To account for this phenomenon, Purfield and Waldron (1999) used the two stage least square technique to study the impact of skewness on the demand for the Irish lottery, Golec and Tamarkin (1998) used data from several U.S. race courses to achieve the same objective, and, using data from the US lottery, Garrett and Sobel (1999) extended the work of Golec and Tamarkin (1998) by studying the significance of return skewness to the expected utility of the lottery players. These studies, as well many others (Woodland and Woodland 1999, Cain et al. 2002), acknowledged that bettors dislike risk but prefer positive skewness. Golec and Tamarkin (1998) and Garrett and Sobel (1999), using a cubic utility function, demonstrated that bettors may accept low-return, high-variance bets in exchange for positive skewness of the bets.

Tein et al. (2006) went on to derive an empirical model (*hereafter referred to as model 2*) which is an extension of the two stage effective price model described earlier (*model 1*). By taking into account bettors accepting unfair bets, model 2 produced improved results compared to the traditional model (model 1).

The expected monetary value of one lottery ticket is calculated as follows:

$$EV = \sum_{i=1}^m Z_i * Pr_ob_i \quad (\text{eq. 4})$$

where:

Z_i is the payoff for the lottery in outcome i

Pr_ob_i is the probability of outcome i .

The *Second Moment* and *Third Moment* in different periods can be calculates as follows:

$$\text{Second Moment} = \sum_{i=1}^m (Z_i - EV)^2 * Pr_ob_i \quad (\text{eq. 5})$$

$$\text{Third Moment} = \sum_{i=1}^m (Z_i - EV)^3 * Pr_ob_i \quad (\text{eq. 6})$$

Stage 1:

$$\text{Effective Price} = f(\text{Sales}_{t-1}, \text{Superdraw}, \text{Rollover}, \text{RolloverSquare}, \text{Trend}, \text{TrendSquare}, \text{Day}) \quad (\text{eq. 7})$$

$$\text{SecondMoment} = f(\text{Sales}_{t-1}, \text{Superdraw}, \text{Rollover}, \text{RolloverSquare}, \text{Trend}, \text{TrendSquare}, \text{Day}) \quad (\text{eq. 8})$$

$$\text{ThirdMoment} = f(\text{Sales}_{t-1}, \text{Superdraw}, \text{Rollover}, \text{RolloverSquare}, \text{Trend}, \text{TrendSquare}, \text{Day}) \quad (\text{eq. 9})$$

Stage 2:

$$\text{Sales}_t = g(\text{Effective Price}, \text{Sales}_{t-1}, \text{Sales}_{t-2}, \text{Sales}_{t-3}, \text{Sales}_{t-4}, \text{Superdraw}, \text{Rollover}, \text{Trend}, \text{TrendSquare}, \text{Day}, \overline{\text{Price}}, \overline{\text{SecondMoment}}, \overline{\text{ThirdMoment}}) \quad (\text{eq. 10})$$

Where:

Effective price = Price of ticket - the expected value of prize receipt (EV).

$\overline{\text{Price}}$ = is the effective price estimated from the first-stage regression.

$\overline{\text{SecondMoment}}$ = is the Second Moment estimation from the first stage.

$\overline{\text{ThirdMoment}}$ = is the Third Moment estimation from the first stage.

$Sales_t$ = the number of the tickets sold;
 $Sales_{t-n}$ = lagged n-period sales, which are included to capture persistence in sales.
 Rollover = amount carried over (not won) from the immediately preceding draw and added to the jackpot pool in the current draw.
 Superdraw = dummy variable that takes value one for a specific draw when the National lottery pre-announced to top-up the current jackpot.
 Trend = sequence of lotto period.
 TrendSquare = square of Trend.
 Day = dummy variable that takes value 1 for Saturday draw and 0 for Wednesday. This dummy is consistent with Forrest et al. (2000), whose UK lotto findings showed that lower sales were achieved on Wednesdays.

2.10 Substitution and Complementarity of lottery games

In economics, goods or services are said to be substitutes if they can be used or consumed in place of one another in at least some of their possible uses. Complements on the other hand are goods or services that are consumed or used together. While complementary goods give additional market power to the company through vendor lock-in and increased switching costs as per Porter's five forces (Porter, 1980), substitutions result in cannibalisation of older products by the new. Kerin et al. (1978) see cannibalisation as "the process by which a new product gains sales by diverting them from an existing product". Mason and Milne (1994) and Copulsky (1976) define cannibalisation as "the extent to which one product's customers are at the expense of other products offered by the same firm."

The issue of substitution among lottery games has been studied quite intensively in literature. Clotfelter and Cook (1989) test the effects of introducing lotto games on the sales of scratch card tickets and do not find any evidence to support substitution. Gulley and Scott (1993) grapple with the question of whether the Mass Millions and Mass Megabucks games in Massachusetts serve as substitutes for one another, also finding no significant relationship between the two. Stover (1990) however finds significant substitution effects between lotteries run by contiguous states. Forrest et al. (2004) also

find evidence of some substitution among the variety of games offered by the United Kingdom National Lottery. Finally, Grote and Matheson (2006) find that the introduction of a multi-state game does serve to reduce sales in an existing state lotto game but the newly generated sales of the multi-state game exceeded the loss of sales in the state game in all three of the cases studied.

To calculate the substitution and complementarity, Forest et al. (2004) modified equation 3 and calculated the effect of each game's sales on other games as follows:

$$\text{LottoSales} = F(\text{Constant}, \text{Trend}, \text{Trend}^2, \text{LottoSales}_{t-1}, \text{WedPrice}, \text{SatPrice}, \text{ThunderSales}_{t-1}, \text{ScratchSales}_{t-1}, \text{OTHER}) \quad (\text{eq. 11})$$

$$\text{ThunderSales} = F(\text{Constant}, \text{Trend}, \text{Trend}^2, \text{ThunderSales}_{t-1}, \text{WedPrice}, \text{SatPrice}, \text{ThunderSales}_{t-1}, \text{ScratchSales}_{t-1}, \text{OTHER}) \quad (\text{eq. 12})$$

$$\text{ScratchSales} = F(\text{Constant}, \text{Trend}, \text{Trend}^2, \text{ScratchSales}_{t-1}, \text{WedPrice}, \text{SatPrice}, \text{ThunderSales}_{t-1}, \text{ScratchSales}_{t-1}, \text{OTHER}) \quad (\text{eq. 13})$$

Using the results from the regression model for the above three equations, an inference is made on whether the products are complements or substitutes. Taking equation 11 as an example, the conclusion depends on whether the coefficient of $\text{ThunderSales}_{t-1}$, $\text{ScratchSales}_{t-1}$, LottoSales_{t-1} is negative (substitute) or positive (complement), as well as on the p-value, which gives an indication of how statistically significant the finding is. Similarly using equations 12 and 13 the process can be repeated with respect to the other games.

3 RESEARCH METHODOLOGY

3.1 Research methodology

A quantitative approach was used in this study, in particular a series of regression analysis using the two stage effective price model. The data was divided into three sections, from 11 March 2000 through to 29 September 2001 when the lottery draw was only conducted on Saturday. The second tranche is from 03 October 2001 through to 22 November 2003 when the biweekly Saturday and Wednesday draws were performed, and the last tranche covers the period after the introduction of the LottoPlus draw between 26 November 2003 and 30 March 2007 (*when Uthingo's operating licence expired*).

The three periods were treated independently of each other, as the change in frequency and the introduction of the lottery game introduced a structural change in the total weekly lotto sales (Forrest et al. 2002); such a shift adds complexity to any estimation procedure and would detract from and possibly muddle attempts to answer the research questions (Forrest et al. 2004).

3.2 Population and sample

Population for the first, second and third part of the research periods comprised all the draws conducted in South Africa using the Lotto machines and LottoPlus machines. While data for periods such as major holidays and voting day was expected to skew the results somewhat, these were included nonetheless in keeping with previous research where draws shortly after Princess Diana's death or around September 11 were included in the UK and US studies respectively.

3.3 Data collection

The data were collected from the inception of the game in 11 March 2000 from the national lottery, which exhibited all 655 draw results since inception up to and including 31 March 2007, and were broken down into the three sections described above. The

data were made up of all the statistics for each draw, such as Sales figures, the number of winners and the prize money for each category from 3 numbers to the jackpot, the roll over amounts, and super jackpot values for both Lotto and LottoPlus games.

3.4 Data analysis and interpretation

The data set consisted of weekly draws in the case of Period 1 (2000-03-11 to 29 September 2001), biweekly draws in Period 2 (2001-10-03 to 2003-11-22), and separate sets for Lotto and LottoPlus draws for last period up to 31 March 2007 when Uthingo's licence expired.

3.4.1 Determining the elasticity of demand

Two models were used: firstly the two stage regression model outlined in equations 1–3 with a few minor changes.

Model 1:

$$ePrice = TicketPrice - \left(\frac{(Rollover + jQ)(1 - e^{-p*Sales})}{Sales} \right) + EV_{non\ jackpot}$$

Stage 1:

$$ePrice = f(ePrice_{t-1}, Sales_{t-1}, Superdraw, Rollover, RolloverSquare, Trend,$$

$$TrendSquare, Day) \quad (eq. 14)$$

Stage 2:

$$Sales_t = g(\overline{ePrice}, Sales_{t-1}, Sales_{t-2}, Sales_{t-3}, Sales_{t-4}, Superdraw, Rollover, Trend,$$

$$TrendSquare, Day, WeekNo) \quad (eq. 15)$$

Where:

ePrice = Effective price of the lottery ticket.

Where ePrice, ePrice_{t-1}, Sales_{t-n}, Trend, TrendSquare are in their natural logs

$\overline{ePrice}$ = is the Effective Price estimated from the first-stage regression.

WeekNo = dummy variable which takes value 1-5 depending on the week of the month.

Day = dummy variable that takes value 1 for Saturday draw and 0 for Wednesday.

The elasticity of demand is evaluated as follows for both methods:

Elasticity = coefficient of Price/(1- (Sum of coefficient of lagged sales))

Model 2:

$$ePrice = TicketPrice - EV \quad (\text{where } EV = \sum_{i=1}^m Z_i * Pr_{ob_i})$$

$$ePrice = TicketPrice - \sum_{i=1}^m Z_i * Pr_{ob_i} \quad (\text{eq. 16})$$

$$Second\ Moment = \sum_{i=1}^m (Z_i - EV)^2 * Pr_{ob_i} \quad (\text{eq. 17})$$

$$Third\ Moment = \sum_{i=1}^m (Z_i - EV)^3 * Pr_{ob_i} \quad (\text{eq. 18})$$

Stage 1:

$$ePrice = f(ePrice_{t-1}, Sales_{t-1}, Superdraw, Rollover, RolloverSquare, Trend, TrendSquare, Day) \quad (\text{eq. 19})$$

$$SecondMoment = f(Sales_{t-1}, Superdraw, Rollover, RolloverSquare, Trend, TrendSquare, Day) \quad (\text{eq. 20})$$

$$ThirdMoment = f(Sales_{t-1}, Superdraw, Rollover, RolloverSquare, Trend, TrendSquare, Day) \quad (\text{eq. 21})$$

Stage 2:

$$\text{Sales}_t = g(\text{Sales}_{t-1}, \text{Sales}_{t-2}, \text{Sales}_{t-3}, \text{Sales}_{t-4}, \text{Superdraw}, \text{Rollover}, \text{Trend}, \text{TrendSquare}, \text{Day}, \text{WeekNo}, \overline{\overline{ePrice}}, \overline{\overline{SecondMoment}}, \overline{\overline{ThirdMoment}}) \quad (\text{eq. 22})$$

Where:

Z_i is the payoff for the lottery in outcome i

Pr_{ob_i} is the probability of outcome i .

EV = Effective value of the ticket .

ePrice = Effective Price of the ticket.

$\overline{\overline{ePrice}}$ = is the effective price estimated from the first-stage regression.

$\overline{\overline{SecondMoment}}$ = is the Second Moment estimation from the first stage.

$\overline{\overline{ThirdMoment}}$ = is the Third Moment estimation from the first stage.

3.4.2 Determining Substitution and/or Complementarity between games

The question of complements or substitutes was evaluated by modifying the second stage of the regression equation to include three past sales figures of the other games.

Stage 2 for the Lotto and LottoPlus Games for Model 1 will be:

$$\text{SalesL}_t = g(\overline{\overline{ePrice}}, \text{Sales}_{t-1}, \text{Sales}_{t-2}, \text{Sales}_{t-3}, \text{Sales}_{t-4}, \text{SalesLP}_{t-1}, \text{SalesLP}_{t-2}, \text{SalesLP}_{t-3}, \text{Rollover}, \text{Trend}, \text{TrendSquare}, \text{Day}, \text{WeekNo})$$

Where Sales_{t-n} and SalesLP_{t-n} are Lotto and LottoPlus sales respectively.

Stage 2 for the Lotto and LottoPlus Games for Model 2 will be:

$$\text{SalesL}_t = g(\text{SalesL}_{t-1}, \text{SalesL}_{t-2}, \text{SalesL}_{t-3}, \text{SalesL}_{t-4}, \text{SalesLP}_{t-1}, \text{SalesLP}_{t-2}, \text{SalesLP}_{t-3}, \text{Superdraw}, \text{Rollover}, \text{Trend}, \text{TrendSquare}, \text{Day}, \text{WeekNo}, \overline{\overline{e\text{Price}}}, \overline{\overline{\text{SecondMoment}}}, \overline{\overline{\text{ThirdMoment}}})$$

From the resultant regression equation, the sign of coefficients of SalesLP_{t-n} on the Lotto Sales equation will determine if the two are complements (positive coefficient) or substitutes (negative coefficient); equally important will be the p-value which determines if the LottoPlus sales have any significant impact on the lotto Sales either as complement or substitute.

3.5 Limitations of the study

To be consistent with prior studies, potential outliers such as election days and other days of national importance were not excluded from the study.

3.6 Reliability of the model

The model gives an R squared value which is a measure of the extent to which the regression equation is explained by the regression equation and dependent variables. The higher the percentage value the more reliable the model.

3.7 Data analysis

A statPro regression tool was used to perform the regression analysis. StaPro is one of the leading portfolio analytical and performance measurement tools used by the asset management industry.

3.8 Validity and Reliability of the model

According to Leedy and Ormrod (2001), the validity of an instrument is how well it measures what it is supposed to be measuring, while reliability refers to the accuracy and consistency with which the instrument produces results.

This study endeavoured to follow an established methodology to answer the research questions outlined earlier. Although the established methodology can be challenged on a number of fronts (as has happened in the past), it remains by far the most tested and accepted methodology, and it has withstood various well considered challenges from various scholars on the subject as shown in the literature review.

3.8.1 Internal validity

- The lottery board was not given advance notice of this study and thus would not have had the opportunity to influence the outcome of this study in any way. The study only used public domain data sets from the lottery board website, which have been corroborated with independent media reports, to safeguard data integrity.
- Consistent with earlier research all the data was included, including that from days which would ordinarily be considered outliers, e.g., the draws performed on the day of national and municipal elections.

3.8.2 External Validity

- While the results of the computed study are based on the South African case study, the research methodology could be used elsewhere in the world. The results will serve as confirmation to studies in other developing countries' lottery studies. They can also be used as a yard stick or benchmark when introducing similar gambling and/or lottery products in other developing countries. Comparisons to similar studies in first world countries whose results are expected to be different can also be made.
- The results could be applied to any generic product line extension which is run concurrently with a market penetration strategy, which was the case in this study.

- The study was voluntarily and objectively undertaken for an MBA program by a researcher with no ties to the government, the lottery board or its associated industries. No gratuity, considerations, or favours of any kind have flowed as a consequence of this study.

3.8.3 Reliability

- To ensure that independent variables are independent of each other, auto-correlating between variables were performed between depended variables before each regression analysis.
- By treating the three periods separately, the researcher acknowledges that the change in frequency and the introduction of the lottery game introduced a structural change in the total weekly lotto sales, consistent with Forrest et al. (2002), and Forrest et al. (2004) who argues that the shift add complexity to any estimation procedure and would detract from and possibly jeopardise efforts to solve the research question.
- Use of a tried and tested tool such as StatPro, as opposed to a designing a new tool or using excel formulae to achieve the same objective, ensures that the reliability of the model is not unduly compromised by unforeseen rounding errors and/or omissions.

4 PRESENTATION OF RESULTS

This chapter presents the results which are broken down into the three periods shown in figure 4. It captures the progression of the lottery through three different stages, from inception when only one draw was conducted, up to when the LottoPlus games were introduced.

The three stages are called Period 1, Period 2 and Period 3 respectively.

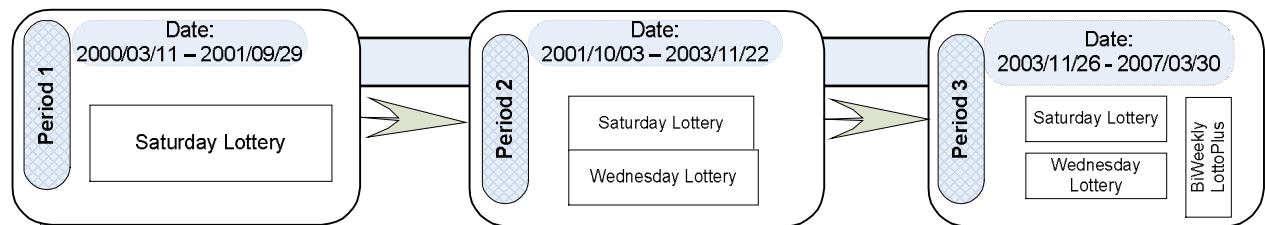


Figure 4 Different Periods used in the analysis

Daily and weekly analyses of sale figures were performed. The former seeks to analyse total daily sales and treats other sales held on different days (even on the same week) as separate, unrelated events. The idea is to get a view of the trend on a day by day basis as the games progressed between the three stages.

The weekly sales analysis however recognises that by increasing the frequency of game consumption per week from once to twice, the total sales achieved per week is actually the sum of Sales from the two draws, and is thus a better indicator, or a proxy, for total revenue collected.

4.1 Total Daily Sales

As shown in table 2 below, summary statistics were conducted for the three periods. For Period 1, when only Saturday draws were conducted, the mean Sales for the Lotto (LT) comes to a figure slightly over R56 Million.

Table 2 The Lottery Sales for the three Periods.

	Daily LT (Period1)	Daily LT (Period 2)	Daily LT (Period 3)	Daily LP (Period 3)	Daily LT+LP (Period 3)
Count	82	223	350	350	350
Mean	56,215,553	40,707,109	30,515,992	8,687,788	39,203,780
Median	54,328,480	38,529,860	29,199,255	8,303,316	37,717,052
Standard deviation	12,218,753	13,479,640	9,379,353	2,534,704	11,785,085
Minimum	22,182,973	19,027,047	13,006,065	3,159,872	16,165,937
Maximum	105,551,300	107,470,590	75,483,553	22,316,852	97,800,405
Range	83,368,328	88,443,543	62,477,487	19,156,981	81,634,468
Variance	1.49E+14	1.82E+14	8.80E+13	6.43E+12	1.39E+14
First quartile	49,582,606	30,251,527	23,257,304	6,872,235	30,274,379
Third quartile	61,848,097	46,518,656	33,618,066	9,395,282	42,935,853
Interquartile range	12,265,491	16,267,130	10,360,763	2,523,047	12,661,474
Mean absolute deviation	8,408,457	10,139,131	6,828,300	1,800,168	8,491,916
Skewness	0.81	1.559	1.501	1.657	1.569
Kurtosis	3.757	3.626	2.474	3.757	2.815
1st percentile	23,567,169	24,648,607	19,973,892	5,968,577	26,352,435
5th percentile	41,679,826	26,484,398	20,838,147	6,171,551	27,526,764
10th percentile	46,327,994	27,626,406	21,559,847	6,435,014	28,267,129
90th percentile	69,332,011	58,681,722	45,113,996	11,948,681	58,069,516
95th percentile	76,549,497	67,539,744	52,296,105	14,664,111	66,730,608
99th percentile	92,982,976	82,736,813	58,407,989	16,404,527	75,007,111

LT = Lotto and LP= LottoPlus.

In Period 2, the Sales figures for the Saturday and Wednesday draws were treated as individual and unrelated data points and the mean for the daily Lotto Sales dropped by 29% compared to the mean in Period 1, down to about R41 Million; increasing frequency of consumption from once to twice a week resulted in a drop in daily sales.

For Period 3, the means for individual Lotto (LT) and LottoPlus (LP) sales conducted on each day are about R31 Million and R9 Million respectively. If we add daily Lotto and LottoPlus for each day, the mean Sales figure comes to about R40 Million.

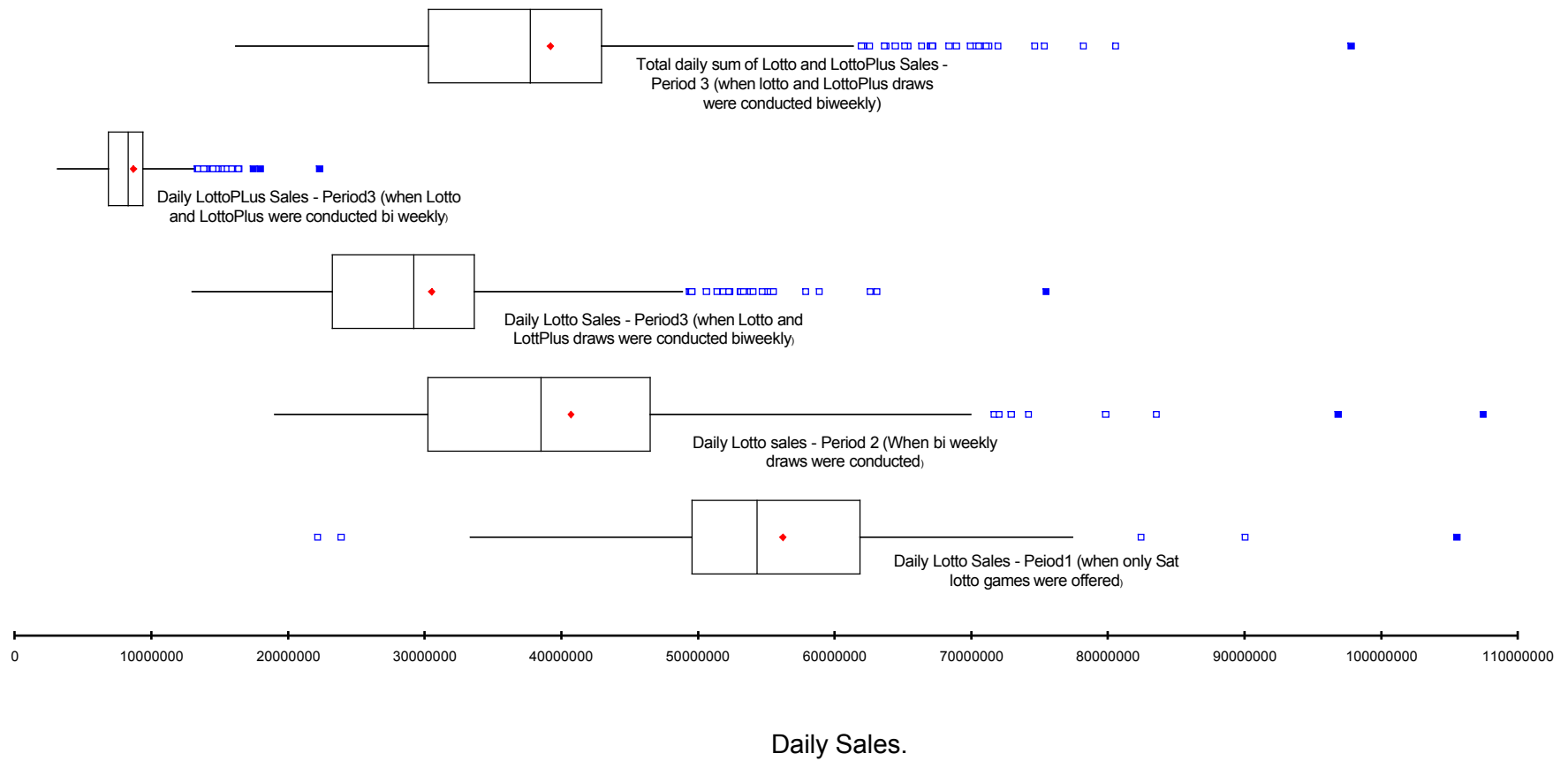


Figure 5 Box Plot of Daily Sales for the three Periods.

This is less than the daily mean for the first two periods, by representing the above data differently using a box plot (see figure 5), where:

- The red dot indicates the mean of Sales, showing period 1 as a clear winner.
- The box itself shows where the middle 50% of the sales data is. The upper edge (hinge) of the box indicates the 75th percentile of the data set, the lower hinge indicates the 25th percentile, and the line in the box indicates the median of sales. From the graph one can see that 75th percentiles of Period 2 and Period 3 are lower than the 25th percentile of period 1.
- Since the median line is not equidistant from the hinges for Period 1 and Period 3 sales, they are skewed to the right and left respectively.
- The end of the solid lines or "whiskers" starting before and after the box extend to 1.5 times the inter-quartile range; the points outside the ends of the whiskers are outliers and suspected outliers. It is worth noting that only period 1 has two very low Sales outliers in addition to the high ones that one would expect due to rollovers.

4.2 Total Weekly Sales

A different picture emerges from the analysis of Total Weekly sales in contrast to the daily sales. Since only one draw was conducted per week in Period 1, the Saturday sales are regarded as the weekly sales. For Period 2 however, the Saturday and Wednesday Sales figures are added together to give a total weekly sales figure. For Period 3, three analysis were conducted: firstly weekly (Saturday and Wednesday) Lottery figures were tallied, the same was done for the LottoPlus, and finally statistics for the total Weekly sales (total Lotto and LottoPlus sales for both Wednesday and Saturday) were also calculated. Table 3 shows the results.

Table 3 **Weekly Sales for the three Periods**

	Total Weekly LT (Period 1)	Total_Weekly_LT (Period 2)	LT Weekly (Period 3)	LP Weekly (Period 3)	Total Weekly LT+LP (Period 3)
Count	82	111	175	175	175
Mean	56,215,553	80,908,315	61,031,984	17,375,575	78,407,559
Median	54,328,480	77,070,302	56,933,060	16,414,639	73,162,879
Standard deviation	12,218,753	24,584,920	10,814,078	2,994,949	13,401,773
Minimum	22,182,973	48,452,132	34,600,537	9,306,907	43,907,444
Maximum	105,551,300	163,396,617	98,415,228	29,759,132	128,174,360
Range	83,368,328	114,944,485	63,814,690	20,452,226	84,266,916
Variance	1.493E+14	6.044E+14	1.169E+14	8.970E+12	1.796E+14
First quartile	49,582,606	60,721,119	53,009,803	15,382,107	68,460,991
Third quartile	61,848,097	93,060,813	68,609,111	18,604,583	87,344,168
Interquartile range	12,265,491	32,339,694	15,599,308	3,222,476	18,883,177
Mean absolute deviation	8,408,457	19,400,995	8,953,452	2,303,021	10,917,202
Skewness	0.810	1.053	0.877	1.121	0.985
Kurtosis	3.757	0.778	0.148	1.648	0.551
1st percentile	23,567,169	49,790,486	47,923,271	11,947,736	63,270,632
5th percentile	41,679,826	53,148,418	49,180,530	14,469,109	64,675,593
10th percentile	46,327,994	55,468,565	50,655,085	14,842,174	66,209,634
90th percentile	69,332,011	116,615,048	76,991,186	22,338,886	98,721,825
95th percentile	76,549,497	131,386,751	79,973,519	23,054,439	102,473,362
99th percentile	92,982,976	146,781,025	88,424,214	25,279,021	111,788,169

LT = Lotto and LP= LottoPlus.

The means show a 31% increase in weekly sales from R56 Million in Period 1 to just under R81 Million in Period 2 followed by a drop to R78 Million when weekly Lotto and LottoPlus are added together in Period 3, representing respectively a 40% increase in sales realised in Period 1 and about 4% drop in sales realised in Period 2. The box plot

below graphically corroborates the above findings, the red dot inside the box plot represents the mean.

- Period 1 is rightly skewed as in the daily sales.
- All Period 3 games are skewed to the right, namely, the weekly lotto sales, the weekly lottoPlus sales and the sum of the two, unlike in the daily Sales analysis where skewness to the left was observed.

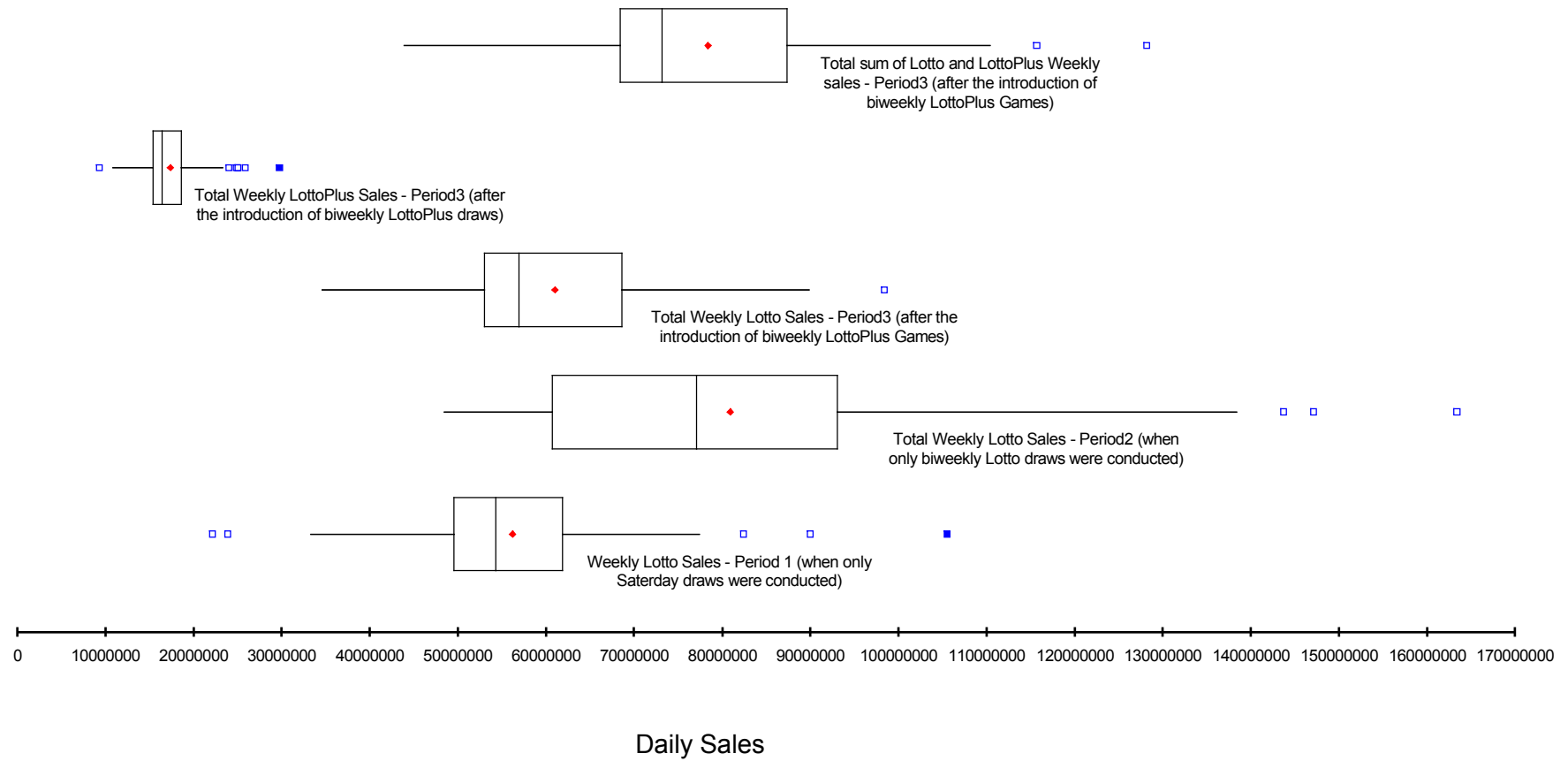


Figure 6 BoxPlot Weekly Sales for the three Periods

4.3 Period 1 Regression Analysis

Since only one draw was conducted in Period 1, the question of complementarity or substitution of games will be answered in relation to lagging sales' impact on current sales. Using the both the traditional and willingness to Pay models, the following results were obtained:

4.3.1 Method 1 – Traditional Model

The following are the results of the first stage of the regression analysis of the traditional model:

Table 4 **Stage 1 results for Traditional Model for Period 1**

Results of multiple regression for Log(Price)

Summary measures

Multiple R	0.6365
R-Square	0.4051
Adj R-Square	0.3655
StErr of Est	0.0150

ANOVA Table

Source	df	SS	MS	F	p-value
Explained	5	0.0115	0.0023	10.2163	0.0000
Unexplained	75	0.0168	0.0002		

Regression coefficients

	Coefficient	Std Err	t-value	p-value	Lower limit	Upper limit
Constant	0.3206	0.0095	33.7224	0.0000	0.3016	0.3395
Log(Price ₋₁)	-0.0479	0.0292	-1.6407	0.1050	-0.1061	0.0103
Rollover(in M)	0.0054	0.0012	4.6904	0.0000	0.0031	0.0077
Rollover ²	-0.0002	0.0001	-2.5796	0.0118	-0.0004	-0.0001
Trend	-0.0002	0.0003	-0.5383	0.5920	-0.0008	0.0004
TrendSq	0.0000	0.0000	0.4035	0.6877	0.0000	0.0000

At 10% confidence level, only the Rollover and the square thereof are significant. The multiple R and R-Square values are sitting at 63% and 40% respectively.

Using the regression equation obtained above, the Log(Price) is recalculated and the fed back to the stage 2 regression equation with other variables, and the resulting Sales regression results are shown in Table 5.

Table 5 **Stage 2 results for Traditional Model for Period 1**

Results of multiple regression for Log(Sale)

Summary measures

Multiple R	0.8636
R-Square	0.7458
Adj R-Square	0.6893
StErr of Est	0.0415

ANOVA Table

Source	df	SS	MS	F	p-value
Explained	14	0.3190	0.0228	13.2013	0.0000
Unexplained	63	0.1087	0.0017		

Regression coefficients

	Coefficient	Std Err	t-value	p-value	Lower limit	Upper limit
Constant	4.3586	1.0600	4.1119	0.0001	2.2404	6.4769
Log(Price)	-2.2826	1.1941	-1.9116	0.0605	-4.6688	0.1036
Log(Price ₋₁)	3.2043	0.5132	6.2438	0.0000	2.1787	4.2298
Log(Price ₋₂)	0.3486	0.6427	0.5424	0.5895	-0.9357	1.6329
Log(Sales ₋₄)	0.1588	0.0750	2.1168	0.0382	0.0089	0.3088
Log(Sales ₋₃)	-0.0803	0.0843	-0.9526	0.3444	-0.2487	0.0881
Log(Sales ₋₂)	0.0201	0.0937	0.2140	0.8312	-0.1672	0.2073
Log(Sales ₋₁)	0.2900	0.1181	2.4560	0.0168	0.0540	0.5260
Rollover(in M)	0.0056	0.0035	1.5748	0.1203	-0.0015	0.0127
Week1	-0.0716	0.0197	-3.6288	0.0006	-0.1110	-0.0321
Week2	-0.0871	0.0188	-4.6289	0.0000	-0.1247	-0.0495
Week3	-0.0875	0.0191	-4.5816	0.0000	-0.1256	-0.0493
Week4	-0.0728	0.0190	-3.8408	0.0003	-0.1107	-0.0349
Trend	0.0015	0.0013	1.1261	0.2644	-0.0012	0.0042
TrendSq	0.0000	0.0000	-0.4358	0.6644	0.0000	0.0000

The following variables are significant at 10 percent confidence level:

- Price – The effective price of the current draw – with a negative coefficient of -2.28.
- Price₋₁ – The effective price of the previous draw. It is important to note the positive coefficient of 3.2 which is higher than the coefficient of effective Price (-2.28).

- Sales₋₄ – Sales achieved 4 weeks previously. Assuming a four week month, this translates to the same week number for the previous month. With a positive coefficient it is thus a complement.
- Sales₋₁ – Previous week's Sales has a positive coefficient therefore a complement.
- Week1-4 → While it is significant which week in a month the draw is conducted, it is also significant to note that the coefficients with relatively stronger sales are achieved in the following weeks in order of magnitude, Week 5, Week 1, Week4 , with Week 2 and Week 3 exhibiting weakest sales, consistent with expectations as the highest sales are predicted around month end when salaries are received.

The following are also worth noteworthy:

- The Rollover and the Trend do not significantly affect Sales.
- The multiple R and R² value are 83% and 69% respectively.

$$\text{Elasticity of demand} = \frac{\text{Price_coef}}{1 - \sum \text{Sales_coef}} = \frac{-2.2826}{1 - (0.1588 - 0.0803 + 0.0201 + 0.29)} = -3.73$$

Where :

Price_coef = Coefficient of effective price.

$\sum \text{Sale_Coef}$ = Sum of coefficients of lagged sales.

4.3.2 Method 2 – Willingness to pay for Period 1

The following are the results (see tables 6–8) of the first and second regression stages of the willingness to pay model:

Table 6 Stage 1 results for Willingness to Pay Model for Period 1

Results of multiple regression for Log(Price)

Summary measures

Multiple R	0.6365
R-Square	0.4051
Adj R-Square	0.3655
StErr of Est	0.0150

ANOVA Table

Source	df	SS	MS	F	p-value
Explained	5	0.0115	0.0023	10.2163	0.0000
Unexplained	75	0.0168	0.0002		

Regression coefficients

	Coefficient	Std Err	t-value	p-value	Lower limit	Upper limit
Constant	0.3206	0.0095	33.7224	0.0000	0.3016	0.3395
Log(Price ₋₁)	-0.0479	0.0292	-1.6407	0.1050	-0.1061	0.0103
Rollover(in M)	0.0054	0.0012	4.6904	0.0000	0.0031	0.0077
Rollover ²	-0.0002	0.0001	-2.5796	0.0118	-0.0004	-0.0001
Trend	-0.0002	0.0003	-0.5383	0.5920	-0.0008	0.0004
TrendSq	0.0000	0.0000	0.4035	0.6877	0.0000	0.0000

Table 7 Results of Multiple Regression for 2ndMoment

Summary measures

Multiple R	0.7449
R-Square	0.5548
Adj R-Square	0.5251
StErr of Est	0.7450

ANOVA Table

Source	df	SS	MS	F	p-value
Explained	5	51.8723	10.3745	18.6931	0.0000
Unexplained	75	41.6241	0.5550		

Regression coefficients

	Coefficient	Std Err	t-value	p-value	Lower limit	Upper limit
Constant	5.8254	0.4729	12.3184	0.0000	4.8833	6.7675
Log(Price ₋₁)	0.5308	1.4529	0.3653	0.7159	-2.3636	3.4252
Rollover(in M)	-0.4370	0.0575	-7.5978	0.0000	-0.5516	-0.3224
Rollover ²	0.0226	0.0046	4.8952	0.0000	0.0134	0.0318
Trend	-0.0012	0.0153	-0.0792	0.9371	-0.0317	0.0293
TrendSq	0.0000	0.0002	0.1227	0.9027	-0.0003	0.0004

Table 8 Results of multiple regression for 3rdMoment

Summary measures

Multiple R	0.7810
R-Square	0.6099
Adj R-Square	0.5839
StErr of Est	1.1799

ANOVA Table

Source	df	SS	MS	F	p-value
Explained	5	163.2804	32.6561	23.4560	0.0000
Unexplained	75	104.4169	1.3922		

Regression coefficients

	Coefficient	Std Err	t-value	p-value	Lower limit	Upper limit
Constant	12.1099	0.7490	16.1680	0.0000	10.6178	13.6020
Log(Price ₋₁)	1.1110	2.3012	0.4828	0.6307	-3.4733	5.6952
Rollover(in M)	-0.7750	0.0911	-8.5076	0.0000	-0.9565	-0.5935
Rollover ²	0.0401	0.0073	5.4862	0.0000	0.0256	0.0547
Trend	0.0022	0.0243	0.0900	0.9285	-0.0462	0.0505
TrendSq	0.0000	0.0003	-0.0286	0.9772	-0.0006	0.0005

When a correlation test was performed on the variables (see Table 9 below), it emerged that the 2nd and 3rd Moments were linearly correlated.

.

Table 9 Correlation results for 2ndMoment and 3rdMoment

Table of correlations			
		2ndMom	3rdmom
	2ndMom	1.000	
	3rdmom	1.000	1.000

The third Moment was thus excluded from the regression equation whose results are shown in table 10 below.

Table 10 Second Stage results for Willingness to pay Model for Period 2.

Results of multiple regression for Log(Sale)

Summary measures

Multiple R	0.8822
R-Square	0.7784
Adj R-Square	0.7247
StErr of Est	0.0391

ANOVA Table

Source	df	SS	MS	F	p-value
Explained	15.000	0.333	0.022	14.516	0.000
Unexplained	62.000	0.095	0.002		

Regression coefficients

	Coefficient	Std Err	t-value	p-value	Lower limit	Upper limit
Constant	16.8347	4.2518	3.9594	0.0002	8.3354	25.3340
2ndMom	-0.3751	0.1243	-3.0186	0.0037	-0.6235	-0.1267
Log(Price)	-36.8475	11.5058	-3.2025	0.0022	-59.8472	-13.8478
Log(Price ₋₁)	1.8756	0.6535	2.8701	0.0056	0.5693	3.1819
Log(Price ₋₂)	0.5072	0.6072	0.8354	0.4067	-0.7065	1.7210
Log(Sales ₋₄)	0.1080	0.0726	1.4874	0.1420	-0.0371	0.2531
Log(Sales ₋₃)	-0.1025	0.0796	-1.2867	0.2030	-0.2617	0.0567
log(Sales ₋₂)	-0.0395	0.0904	-0.4373	0.6634	-0.2202	0.1412
Log(Sales ₋₁)	0.5117	0.1332	3.8411	0.0003	0.2454	0.7780
Rollover(in M)	0.0321	0.0094	3.4155	0.0011	0.0133	0.0510
Week1	-0.0702	0.0186	-3.7839	0.0004	-0.1074	-0.0331
Week2	-0.0849	0.0177	-4.7867	0.0000	-0.1203	-0.0494
Week3	-0.0724	0.0186	-3.8843	0.0003	-0.1097	-0.0351
Week4	-0.0646	0.0180	-3.5829	0.0007	-0.1007	-0.0286
Trend	-0.0046	0.0024	-1.9358	0.0575	-0.0094	0.0002
TrendSq	0.0001	0.0000	2.2361	0.0290	0.0000	0.0001

The following are worth noting from the results:

- The multiple R and R² value are 88% and 77% respectively (up from 86% and 74% from the traditional model). The second method shows a better fit than the first.

- Elasticity of demand = $\frac{\text{Price_coef}}{1 - \sum \text{Sales_coef}} = \frac{-36.8475}{1 - (0.1080 - 0.1025 - 0.0395 + 0.5117)} = -70.49$

At 10 % confidence interval, the following variables are statistically significant in addition to the constant:

- The second Moment.
- Price – the effective price of the current draw; apart from the negative coefficient, its magnitude of -36.8 shows this variable as the single most dominant contributor to sales.
- Price₋₁ – The effective price of the previous draw is statistically significant and its coefficient is the second largest and positive at 1.8.
- Sale₋₁ – Sales figures for the previous week are statistically significant and Sale₋₁ is a complement due to its positive coefficient.
- Rollover (in Millions) amount is significant statistically but, with a coefficient of 0.031, its impact is not significant considering the biggest rollovers are around R40 Million.
- The week of the month in which the draw is conducted is significant.
- Trend is also significant but is negative; the more people know about the lotto, the less inclined they are to participate. The coefficient is also miniscule indicating not such a remarkable contribution to sales as compared to the other variables.
- Trend² is also significant but small.

4.3.3 Comparing the results from the two Models for Period 1

Table 11 Comparing the two Models for Period 1

		Method1 - Traditional Model			Method- Willingness to Pay		
Summary measures							
Multiple R		0.8636			0.8822		
R-Square		0.7458			0.7784		
Adj R-Square		0.6893			0.7247		
StErr of Est		0.0415			0.0391		
ANOVA Table							
Source	df	F	p-value		df	F	p-value
Explained	14	13.2013	0		15	14.516	0.000
Unexplained	63				62		
Regression coefficients							
	Coefficient	Std Err	p-value		Coefficient	Std Err	p-value
Constant	4.359	1.060	0.000		16.835	4.252	0.000
2ndMom	N/A				-0.375	0.124	0.004
Log(Price)	-2.283	1.194	0.061		-36.848	11.506	0.002
Log(Price ₋₁)	3.204	0.513	0.000		1.876	0.653	0.006
Log(Price ₋₂)	0.349	0.643	0.590		0.507	0.607	0.407
Log(Sales ₋₄)	0.159	0.075	0.038		0.108	0.073	0.142
Log(Sales ₋₃)	-0.080	0.084	0.344		-0.102	0.080	0.203
Log(Sales ₋₂)	0.020	0.094	0.831		-0.040	0.090	0.663
Log(Sale ₋₁)	0.290	0.118	0.017		0.512	0.133	0.000
Rollover(in M)	0.006	0.004	0.120		0.032	0.009	0.001
Week1	-0.072	0.020	0.001		-0.070	0.019	0.000
Week2	-0.087	0.019	0.000		-0.085	0.018	0.000
Week3	-0.088	0.019	0.000		-0.072	0.019	0.000
Week4	-0.073	0.019	0.000		-0.065	0.018	0.001
Trend	0.002	0.001	0.264		-0.005	0.002	0.057
TrendSq	0.000	0.000	0.664		0.000	0.000	0.029

The statistically significant variables are highlighted above, and:

- There is a notable improvement from the first to the second method all round.
- The Rollover is significant for Method 2 and not for the Model 1.
- Trend and TrendSq are also significant for Model 2 and not Model 1.

Method 2 is the better of the two models and is the better Model all round.

4.4 Period 2 Sales results.

To recap, Period 2 is the period when biweekly Saturday and Wednesday draws were conducted and is prior to the introduction of the LottoPlus games.

4.4.1 Method 1 – Traditional Model

Using the traditional Model, results in Table 12 and 13 were obtained:

Table 12 Results of 1st Stage Multiple regression for Period 2

Results of multiple regression for Log(Price)

Summary measures

Multiple R	0.6406
R-Square	0.4104
Adj R-Square	0.3940
StErr of Est	0.0192

ANOVA Table

Source	df	SS	MS	F	p-value
Explained	6	0.0550	0.0092	24.9440	0.0000
Unexplained	215	0.0791	0.0004		

Regression coefficients

	Coefficient	Std Err	t-value	p-value	Lower limit	Upper limit
Constant	0.3996	0.0206	19.4273	0.0000	0.3590	0.4401
Log(Price ₋₁)	-0.3250	0.0533	-6.0945	0.0000	-0.4301	-0.2199
Rollover(in M)	0.0062	0.0006	10.2229	0.0000	0.0050	0.0074
Rollover ²	-0.0002	0.0000	-7.1424	0.0000	-0.0002	-0.0001
Trend	0.0000	0.0001	0.0886	0.9295	-0.0003	0.0003
TrendSq	0.0000	0.0000	-0.1487	0.8819	0.0000	0.0000
Wed	-0.0010	0.0026	-0.3957	0.6927	-0.0061	0.0041

Table 13 Results of 2nd Stage multiple regression for Period 2

Results of multiple regression for Log(Sale)

Summary measures

Multiple R	0.8315
R-Square	0.6914
Adj R-Square	0.6718
StErr of Est	0.0741

ANOVA Table

Source	df	SS	MS	F	p-value
Explained	13	2.5252	0.1942	35.3305	0.0000
Unexplained	205	1.1271	0.0055		

Regression coefficients

	Coefficient	Std Err	t-value	p-value	Lower limit	Upper limit
Constant	4.639	0.751	6.174	0.000	3.158	6.121
Log(Price)	-2.673	0.444	-6.019	0.000	-3.549	-1.798
Log(Sales _{.4})	0.358	0.059	6.074	0.000	0.241	0.474
Log(Sales _{.3})	-0.203	0.058	-3.511	0.001	-0.317	-0.089
Log(Sales _{.2})	0.308	0.057	5.357	0.000	0.194	0.421
Log(Sale _{.1})	0.050	0.062	0.817	0.415	-0.071	0.172
Rollover(in M)	0.011	0.001	8.009	0.000	0.008	0.014
Trend	-0.001	0.001	-1.470	0.143	-0.002	0.000
TrendSq	0.000	0.000	1.146	0.253	0.000	0.000
Wed	-0.005	0.010	-0.453	0.651	-0.025	0.016
Week1	0.006	0.021	0.267	0.790	-0.036	0.047
Week2	-0.081	0.022	-3.685	0.000	-0.124	-0.038
Week3	-0.076	0.021	-3.531	0.001	-0.118	-0.033
Week4	-0.033	0.021	-1.566	0.119	-0.075	0.009

At 10% confidence level, the following are notable with regards to impact on Sales for the current week:

- The effective price of the current draw is statistically significant, and affects Sales in a negative way.
- Sales figures on the same day of the week but in different weeks; Sales_{.2} and Sales_{.4} are statistically significant, have a positive coefficient, and therefore are complements.
- Sales_{.3} – Sales for a different day of the week, three draws prior to the current draw is not only statistically significant but it also has a negative coefficient, which implies a substitute.

- Sales₋₁ , which is the immediate past Sales that falls on a different day of the week, is not statistically significant. No relationship could be inferred on Saturday and Wednesday sales conducted immediately before or after each other.
- Since the Wednesday variable is not significant, whether the draw is conducted on the Wednesday or Saturday, one cannot statistically infer at 10% confidence level.
- It also seems to matter which week of the Month it is. In Week 2 and Week 3, lower sales should be expected, which could be predicted considering Week 4 and Week 5 are usually month end and Week 1 the beginning of the month.

$$\text{Elasticity of demand} = \frac{\text{Price_coef}}{1 - \sum \text{Sales_coef}} = \frac{-2.673}{1 - (0.358 - 0.203 + 0.308 + 0.050)} = -5.49$$

4.4.2 Method 2 – Willingness to Pay

The following results were obtained from the regression analysis on the willingness to pay method:

Table 14 Results for Stage1 - Willingness to Pay Model for Period 2

Results of multiple regression for Log(Price)

Summary measures

Multiple R	0.6406
R-Square	0.4104
Adj R-Square	0.3940
StErr of Est	0.0192

ANOVA Table

Source	df	SS	MS	F	p-value
Explained	6	0.0550	0.0092	24.9440	0.0000
Unexplained	215	0.0791	0.0004		

Regression coefficients

	Coefficient	Std Err	t-value	p-value	Lower limit	Upper limit
Constant	0.3996	0.0206	19.4273	0.0000	0.3590	0.4401
Log(Price ₋₁)	-0.3250	0.0533	-6.0945	0.0000	-0.4301	-0.2199
Rollover(in M)	0.0062	0.0006	10.2229	0.0000	0.0050	0.0074
Rollover ²	-0.0002	0.0000	-7.1424	0.0000	-0.0002	-0.0001
Trend	0.0000	0.0001	0.0886	0.9295	-0.0003	0.0003
TrendSq	0.0000	0.0000	-0.1487	0.8819	0.0000	0.0000
Wed	-0.0010	0.0026	-0.3957	0.6927	-0.0061	0.0041

Results of multiple regression for 2ndMoment

Summary measures

Multiple R	0.7265
R-Square	0.5278
Adj R-Square	0.5146
StErr of Est	0.8228

ANOVA Table

Source	df	SS	MS	F	p-value
Explained	6	162.6783	27.1131	40.0492	0.0000
Unexplained	215	145.5536	0.6770		

Regression coefficients

	Coefficient	Std Err	t-value	p-value	Lower limit	Upper limit
Constant	2.0443	0.8824	2.3168	0.0215	0.3051	3.7836
Log(Price ₋₁)	12.2003	2.2881	5.3321	0.0000	7.6904	16.7102
Rollover(in M)	-0.3591	0.0259	-13.8613	0.0000	-0.4102	-0.3081
Rollover ²	0.0103	0.0010	9.9127	0.0000	0.0082	0.0123
Trend	0.0008	0.0059	0.1281	0.8982	-0.0109	0.0125
TrendSq	0.0000	0.0000	-0.2937	0.7692	0.0000	0.0000
Wed	0.0158	0.1114	0.1418	0.8874	-0.2038	0.2354

Results of multiple regression for 3rdMoment

Summary measures

Multiple R	0.7374
R-Square	0.5438
Adj R-Square	0.5310
StErr of Est	1.3684

ANOVA Table

Source	df	SS	MS	F	p-value
Explained	6	479.8551	79.9758	42.7081	0.0000
Unexplained	215	402.6120	1.8726		

Regression coefficients

	Coefficient	Std Err	t-value	p-value	Lower limit	Upper limit
Constant	6.0619	1.4676	4.1305	0.0001	3.1692	8.9546
Log(Price-1)	19.8856	3.8054	5.2256	0.0000	12.3850	27.3863
Rollover(in M)	-0.6205	0.0431	-14.4003	0.0000	-0.7055	-0.5356
Rollover ²	0.0178	0.0017	10.3339	0.0000	0.0144	0.0212
Trend	0.0017	0.0099	0.1725	0.8632	-0.0178	0.0212
TrendSq	0.0000	0.0000	-0.3622	0.7176	-0.0001	0.0000
Wed	0.0087	0.1853	0.0467	0.9628	-0.3565	0.3739

Similar to Period 1, the 2ndMoment and 3rdMoment were again found to be linearly correlated, and only one of these two variables was used for the final regression equation whose results are shown below.

Table 15 Results for Stage2 - Willingness to Pay Model for Period 2

Results of multiple regression for Log(Sale)

Summary measures

Multiple R	0.8337
R-Square	0.6950
Adj R-Square	0.6741
StErr of Est	0.0739

ANOVA Table

Source	df	SS	MS	F	p-value
Explained	14	2.5385	0.1813	33.2108	0.0000
Unexplained	204	1.1138	0.0055		

Regression coefficients

	Coefficient	Std Err	t-value	p-value	Lower limit	Upper limit
Constant	5.8002	1.0554	5.4957	0.0000	3.7193	7.8812
3rdmom	-0.0403	0.0258	-1.5609	0.1201	-0.0912	0.0106
Log(Price)	-6.2740	2.3489	-2.6710	0.0082	-10.9053	-1.6427
Log(Sales _{.4})	0.3539	0.0587	6.0284	0.0000	0.2381	0.4696
Log(Sales _{.3})	-0.2316	0.0605	-3.8300	0.0002	-0.3508	-0.1124
Log(Sales _{.2})	0.3224	0.0580	5.5591	0.0000	0.2081	0.4368
Log(Sales _{.1})	0.1197	0.0758	1.5782	0.1161	-0.0298	0.2692
Rollover(in M)	0.0099	0.0015	6.4445	0.0000	0.0068	0.0129
Trend	-0.0006	0.0006	-1.0731	0.2845	-0.0018	0.0005
TrendSq	0.0000	0.0000	0.5936	0.5534	0.0000	0.0000
Wed	-0.0081	0.0105	-0.7712	0.4415	-0.0289	0.0126
Week1	0.0067	0.0210	0.3188	0.7502	-0.0347	0.0481
Week2	-0.0786	0.0219	-3.5924	0.0004	-0.1218	-0.0355
Week3	-0.0762	0.0214	-3.5671	0.0004	-0.1183	-0.0341
Week4	-0.0332	0.0211	-1.5777	0.1162	-0.0748	0.0083

At 10% confidence level, the following variables significantly affect Sales:

- The effective price, with a negative coefficient of -6.27.
- Just like in the first model, sales achieved four and two draws previously, that is the same day on different week, are statistically significant, positively affect current sales, and are therefore complements.
- The Sales on different days also have not changed. The Sales on the draw immediately preceding the current ($Sales_{-1}$) remains insignificant, and the one from three draws previous ($Sales_{-3}$) is statistically significant, negatively affects current Sales, and is thus a substitute.
- The weeks in the middle of the month (week 2 and week3) continue to record weaker Sales.

$$\text{Elasticity of demand} = \frac{\text{Price}_{-coef}}{1 - \sum \text{Sales}_{-coef}} = \frac{-6.2740}{1 - (0.3539 - 0.2316 + 0.3224 + 0.1197)} = -14.40$$

4.4.3 Comparing the results from the two Models for Period 2

As shown in table 16 below, at 10% confidence level, the Willingness to pay does not significantly enhance the traditional model; apart from the slight improvement in the Multiple R and R^2 value, the 3rdMoment is also statistically insignificant.

Table 16 Comparing the two Models for Period 2

	Method 1- Traditional Model			Method 2- Willingness to Pay		
<i>Summary measures</i>						
Multiple R	0.8315			0.8337		
R-Square	0.6914			0.695		
Adj R-Square	0.6718			0.6741		
StErr of Est	0.0741			0.0739		
<i>ANOVA Table</i>						
Source	df	F	p-value	df	F	p-value
Explained	13	35.3305	0	14	33.2108	0
Unexplained	205			204		
<i>Regression coefficients</i>						
	Coefficient	Std Err	p-value	Coefficient	Std Err	p-value
Constant	4.639	0.751	0	5.8002	1.0554	0
3rdMoment	N/A			-0.0403	0.0258	0.1201
Log(Price)	-2.673	0.444	0	-6.274	2.3489	0.0082
Log(Sales _{.4})	0.358	0.059	0	0.3539	0.0587	0
Log(Sales _{.3})	-0.203	0.058	0.001	-0.2316	0.0605	0.0002
Log(Sales _{.2})	0.308	0.057	0	0.3224	0.058	0
Log(Sales _{.1})	0.05	0.062	0.415	0.1197	0.0758	0.1161
Rollover(in M)	0.011	0.001	0	0.0099	0.0015	0
Trend	-0.001	0.001	0.143	-0.0006	0.0006	0.2845
TrendSq	0	0	0.253	0	0	0.5534
Wed	-0.005	0.01	0.651	-0.0081	0.0105	0.4415
Week1	0.006	0.021	0.79	0.0067	0.021	0.7502
Week2	-0.081	0.022	0	-0.0786	0.0219	0.0004
Week3	-0.076	0.021	0.001	-0.0762	0.0214	0.0004
Week4	-0.033	0.021	0.119	-0.0332	0.0211	0.1162

4.5 Period 3 Sales results.

Period 3 is the third and final last stage of the investigation when the LottoPlus games were introduced to both the Wednesday and the Saturday draws. The results for the traditional method are as follows:

Table 17 Traditional Model results for Period 3

4.5.1 Method 1 – Traditional Model

Results of multiple regression for Log(Price)

Summary measures

Multiple R	0.5889
R-Square	0.3468
Adj R-Square	0.3354
StErr of Est	0.0278

ANOVA Table

Source	df	SS	MS	F	p-value
Explained	6	0.1410	0.0235	30.3485	0.0000
Unexplained	343	0.2655	0.0008		

Regression coefficients

	Coefficient	Std Err	t-value	p-value	Lower limit	Upper limit
Constant	0.3982	0.0386	10.3219	0.0000	0.3223	0.4741
Log(Price ₁)	-0.2306	0.0399	-5.7784	0.0000	-0.3091	-0.1521
Rollover(in M)	0.0086	0.0008	11.0809	0.0000	0.0070	0.0101
Rollover ²	-0.0003	0.0000	-7.8902	0.0000	-0.0004	-0.0002
Trend	-0.0002	0.0002	-1.0238	0.3067	-0.0005	0.0001
TrendSq	0.0000	0.0000	1.1460	0.2526	0.0000	0.0000
Wed	-0.0074	0.0030	-2.4526	0.0147	-0.0133	-0.0015

Results of multiple regression for log(Sale)

Summary measures

Multiple R	0.9782
R-Square	0.9568
Adj R-Square	0.9550
StErr of Est	0.0252

ANOVA Table

Source	df	SS	MS	F	p-value
Explained	14	4.6522	0.3323	524.1185	0.0000
Unexplained	331	0.2099	0.0006		

Regression coefficients

	Coefficient	Std Err	t-value	p-value	Lower limit	Upper limit
Constant	1.3226	0.2591	5.1051	0.0000	0.8130	1.8322
Log(Sale_LP)	0.9369	0.0193	48.5920	0.0000	0.8990	0.9748
Log(Sale_LP ₋₁)	0.0507	0.0178	2.8513	0.0046	0.0157	0.0857
Log(Sales_LP ₋₂)	-0.0062	0.0174	-0.3580	0.7205	-0.0403	0.0279
Log(Sale_LP ₋₃)	0.0128	0.0172	0.7421	0.4586	-0.0211	0.0466
Log(Sales_LP ₋₄)	-0.0437	0.0170	-2.5651	0.0108	-0.0771	-0.0102
Log(Price)	-0.1542	0.0828	-1.8616	0.0635	-0.3171	0.0087
Trend	-0.0012	0.0002	-8.2097	0.0000	-0.0015	-0.0009
TrendSq	0.0000	0.0000	6.0004	0.0000	0.0000	0.0000
Rollover ² (in M)	0.0000	0.0000	2.6366	0.0088	0.0000	0.0001
Wed	-0.0411	0.0068	-6.0367	0.0000	-0.0545	-0.0277
Week1	-0.0009	0.0057	-0.1593	0.8735	-0.0121	0.0103
Week2	-0.0006	0.0059	-0.0989	0.9212	-0.0122	0.0111
Week3	0.0053	0.0058	0.9123	0.3623	-0.0062	0.0168
Week4	-0.0028	0.0057	-0.4981	0.6188	-0.0141	0.0084

At 10% confidence level we note the following:

- Current LottoPlus Sales (Sale_LP) draw conducted simultaneously with the Lotto is statistically significant and is a complement.
- The LottoPlus conducted immediately before the current draw (SaleLP₋₁) is significant and is complementary; it is important to note that this draw was conducted on a different day to the current draw.
- It is now significant which day (Saturday or Wednesday) the draw is conducted on; lower sales figures are expected on Wednesday draws.

- Which week in the month the draw is conducted on is no longer statistically significant.

Considering the lagging sales variables were excluded from the regression equation due to linear collinearity with their lagging LottoPlus sales counterparts (table 18), the following can be inferred with regards to lagging Sales.

Table 18 Stage 1 variable correlation results

Table of correlations

	Log(Sale_LP ₋₁)	Log(Sales_LP ₋₂)	Log(Sales_LP ₋₃)	Log(Sales_LP ₋₄)
2ndMom				
3rdmom				
Log(Sale_LP ₋₁)	1			
Log(Sales_LP ₋₂)	-0.261	1		
Log(Sales_LP ₋₃)	0.429	-0.261	1	
Log(Sales_LP ₋₄)	-0.421	0.427	-0.26	1
log(Sales ₋₁)	0.9	-0.342	0.391	-0.503
Log(Sales ₋₂)	-0.358	0.9	-0.342	0.388
Log(Sales ₋₃)	0.393	-0.358	0.9	-0.343
Log(Sales ₋₄)	-0.501	0.391	-0.358	0.9
Rollover(in M)	-0.014	0.092	-0.05	0.032

- Since the previous lotto sales Sale₋₁ is linearly correlated to SaleLP₋₁, it is also significant and a complement.
- The LottoPlus sale (SaleLP₋₄) conducted on the same day two weeks prior to the current draw is statistically significant and is a substitute.
- Since the previous lotto sales Sale₋₄ is linearly correlated to SaleLP₋₄ (table 20), it is also significant and a substitute

$$\text{Elasticity of demand} = \frac{\text{Price_coef}}{1 - \sum \text{Sales_coef}} = \frac{-0.1542}{1 - (0.0507 - 0.0062 + 0.0128 - 0.0437)} = -0.156$$

4.5.2 Method 2 – Willingness to Pay

The results for the Willingness to Pay model are as follows:

Table 19 **Stage 1 results for Willingness to Pay Model for Period 3**

**Results of multiple regression for
Log(Price)**

**Summary
measures**

Multiple R	0.5889
R-Square	0.3468
Adj R-Square	0.3354
StErr of Est	0.0278

ANOVA Table

Source	df	SS	MS	F	p-value
Explained	6	0.1410	0.0235	30.3485	0.0000
Unexplained	343	0.2655	0.0008		

Regression coefficients

	Coefficient	Std Err	t-value	p-value	Lower limit	Upper limit
Constant	0.3982	0.0386	10.3219	0.0000	0.3223	0.4741
Log(Price ₋₁)	-0.2306	0.0399	-5.7784	0.0000	-0.3091	-0.1521
Rollover(in M)	0.0086	0.0008	11.0809	0.0000	0.0070	0.0101
Rollover ²	-0.0003	0.0000	-7.8902	0.0000	-0.0004	-0.0002
Trend	-0.0002	0.0002	-1.0238	0.3067	-0.0005	0.0001
TrendSq	0.0000	0.0000	1.1460	0.2526	0.0000	0.0000
Wed	-0.0074	0.0030	-2.4526	0.0147	-0.0133	-0.0015

Results of multiple regression for 2ndMoment**Summary measures**

Multiple R	0.7237
R-Square	0.5237
Adj R-Square	0.5154
StErr of Est	0.9055

ANOVA Table

Source	df	SS	MS	F	p-value
Explained	6	309.2035	51.5339	62.8521	0.0000
Unexplained	343	281.2337	0.8199		

Regression coefficients

	Coefficient	Std Err	t-value	p-value	Lower limit	Upper limit
Constant	4.9792	1.2557	3.9654	0.0001	2.5095	7.4490
Log(Price ₋₁)	4.9509	1.2988	3.8119	0.0002	2.3963	7.5055
Rollover(in M)	-0.4171	0.0252	-16.5705	0.0000	-0.4667	-0.3676
Rollover ²	0.0144	0.0012	11.8514	0.0000	0.0120	0.0167
Trend	-0.0040	0.0051	-0.7730	0.4401	-0.0141	0.0061
TrendSq	0.0000	0.0000	0.6640	0.5071	0.0000	0.0000
Wed	0.5921	0.0978	6.0537	0.0000	0.3997	0.7845

Results of multiple regression for 3rdMoment**Summary measures**

Multiple R	0.7316
R-Square	0.5352
Adj R-Square	0.5271
StErr of Est	1.5164

ANOVA Table

Source	df	SS	MS	F	p-value
Explained	6	908.2078	151.3680	65.8275	0.0000
Unexplained	343	788.7161	2.2995		

Regression coefficients

	Coefficient	Std Err	t-value	p-value	Lower limit	Upper limit
Constant	11.3390	2.1028	5.3924	0.0000	7.2030	15.4750
Log(Price-1)	7.6447	2.1750	3.5148	0.0005	3.3667	11.9228
Rollover(in M)	-0.7203	0.0422	-17.0849	0.0000	-0.8032	-0.6373
Rollover ²	0.0249	0.0020	12.2861	0.0000	0.0209	0.0289
Trend	-0.0083	0.0086	-0.9575	0.3390	-0.0252	0.0087
TrendSq	0.0000	0.0000	0.8602	0.3903	0.0000	0.0000
Wed	0.9935	0.1638	6.0655	0.0000	0.6713	1.3157

A few variables were excluded from the final stage after being found to be linearly correlated to each other as shown in table 20.

Table 20 Correlation for Willingness to pay Model (Period 3)

Table of correlations

	2ndMom	3rdMom	log (Sale_LP-1)	Log (Sales_LP-2)	log (Sale_LP-3)	Log (Sales_LP-4)
2ndMom	1.000					
3rdmom	1.000	1.000				
Log(Sale_LP-1)	-0.195	-0.180	1.000			
Log(Sales_LP-2)	0.167	0.165	-0.261	1.000		
Log(Sales_LP-3)	-0.200	-0.195	0.429	-0.261	1.000	
Log(Sales_LP-4)	0.161	0.155	-0.421	0.427	-0.260	1.000
log(Sales-1)	-0.199	-0.186	0.900	-0.342	0.391	-0.503
Log(Sales-2)	0.208	0.203	-0.358	0.900	-0.342	0.388
Log(Sales-3)	-0.186	-0.182	0.393	-0.358	0.900	-0.343
Log(Sales-4)	0.186	0.179	-0.501	0.391	-0.358	0.900
Rollover(in M)	-0.698	-0.699	-0.014	0.092	-0.050	0.032

The following variables were thus excluded from the final regression equation:

- 2nd Moment since it is linearly correlated with 3rd Moment.
- LottoPlus sales from the previous draw (Sales_LP-1); its behaviour is captured by the lotto Sales of the same draw (Sales -1).
- All Previous Lotto Sales (Sales-4, Sales-3, Sales-2) were also excluded on the same basis, due to their linear correlation with Sales_LP-4, Sales_LP-3, Sales_LP-2 respectively.

The resulting regression analysis gave the results on the next page:

Table 21 Stage 2 results for Willingness to pay Model for Period 3

Results of multiple regression for log(Sale)

Summary measures

Multiple R	0.9782
R-Square	0.9569
Adj R-Square	0.9550
StErr of Est	0.0252

ANOVA Table

Source	df	SS	MS	F	p-value
Explained	15	4.6526	0.3102	488.7660	0.0000
Unexplained	330	0.2094	0.0006		

Regression coefficients

	Coefficient	Std Err	t-value	p-value	Lower limit	Upper limit
Constant	1.2029	0.2965	4.0573	0.0001	0.6197	1.7862
3rdmom	0.0039	0.0046	0.8311	0.4065	-0.0053	0.0130
Log(Sales_LP)	0.9415	0.0201	46.9004	0.0000	0.9020	0.9810
Log(Sales_LP ₋₁)	0.0404	0.0217	1.8588	0.0640	-0.0024	0.0831
Log(Sales_LP ₋₂)	-0.0071	0.0174	-0.4085	0.6832	-0.0413	0.0271
log(Sales_LP ₋₃)	0.0134	0.0172	0.7809	0.4354	-0.0204	0.0473
Log(Sales_LP ₋₄)	-0.0428	0.0171	-2.5083	0.0126	-0.0764	-0.0092
Log(Price)	0.1514	0.3769	0.4017	0.6882	-0.5899	0.8927
Trend	-0.0012	0.0002	-6.5428	0.0000	-0.0015	-0.0008
TrendSq	0.0000	0.0000	4.6004	0.0000	0.0000	0.0000
Rollover ² (in M)	0.0000	0.0000	2.7294	0.0067	0.0000	0.0001
Wed	-0.0378	0.0079	-4.7682	0.0000	-0.0534	-0.0222
Week1	-0.0008	0.0057	-0.1366	0.8914	-0.0120	0.0105
Week2	-0.0001	0.0060	-0.0138	0.9890	-0.0118	0.0116
Week3	0.0056	0.0058	0.9527	0.3414	-0.0059	0.0171
Week4	-0.0028	0.0057	-0.4947	0.6211	-0.0141	0.0084

From the results the following are significant at 10% confidence level:

- The Lottery Sales is significantly affected by both the LottoPlus sales (Sale_LP) conducted on the same day and is a complement.
- LottoPlus Sales (Sale_LP₋₁) from the previous draw, with a positive coefficient is a complement, and so is previous Lotto sales (Sale₋₁) due to linear collinearity between the two variables.
- The Trend and Trend² negatively affect the Sales, showing user fatigue.

- The Rollover² is significant and lower revenue should be expected on Wednesday.

4.5.3 Comparing the results from the two Models for Period 3

As shown below, the difference between the two methods is negligible.

Table 22 Comparing the two Models for Period 3

Summary measures	Method1-Traditional Model				Method2-Willingness to Pay Model			
	Multiple R				0.9782			
	R-Square				0.9568			
	Adj R-Square				0.955			
	StErr of Est				0.0252			
ANOVA Table								
Source	df	F	p-value	df	F	p-value		
Explained	14	524.1185	0	15	488.766	0		
Unexplained	331			330				
Regression coefficients								
	Coefficient	Std Err	p-value	Coefficient	Std Err	p-value		
Constant	1.3226	0.2591	0	1.2029	0.2965	0.0001		
3rdmom				0.0039	0.0046	0.4065		
Log(Sale_LP)	0.9369	0.0193	0	0.9415	0.0201	0		
Log(Sales_LP ₋₁)	0.0507	0.0178	0.0046	0.0404	0.0217	0.064		
Log(Sales_LP ₋₂)	-0.0062	0.0174	0.7205	-0.0071	0.0174	0.6832		
Log(Sales_LP ₋₃)	0.0128	0.0172	0.4586	0.0134	0.0172	0.4354		
Log(Sales_LP ₋₄)	-0.0437	0.017	0.0108	-0.0428	0.0171	0.0126		
Log(Price)	-0.1542	0.0828	0.0635	0.1514	0.3769	0.6882		
Trend	-0.0012	0.0002	0	-0.0012	0.0002	0		
TrendSq	0	0	0	0	0	0		
Rollover ² (in M)	0	0	0.0088	0	0	0.0067		
Wed	-0.0411	0.0068	0	-0.0378	0.0079	0		
Week1	-0.0009	0.0057	0.8735	-0.0008	0.0057	0.8914		
Week2	-0.0006	0.0059	0.9212	-0.0001	0.006	0.989		
Week3	0.0053	0.0058	0.3623	0.0056	0.0058	0.3414		
Week4	-0.0028	0.0057	0.6188	-0.0028	0.0057	0.6211		

5 DISCUSSION OF RESULTS

5.1 Period 1 Discussion of results.

5.1.1 Sales figures

As shown earlier in the literature review, the mandate of the lottery board is to maximise revenue collected on behalf of government and good causes. Revenue collected per week was increased from R56 Million in Period 1, to R81 Million in Period 2 and then down to R78 Million in Period 3. If one considers that there are both fixed and transactional costs associated with introducing the second game, the net drop in revenue to good causes is expected to be significantly more than 3.7% drop from Period 2 to Period 3.

For revenue to be maximised, the elasticity of demand should be -1 according to literature; it was nowhere near this figure for all three periods, thus suggesting perhaps the design requires a review.

5.1.2 Effective Price

Looking at the regression equation for Period 1 and Period 2 for both methods, the coefficient of effective price for the current week and that of the previous week are relatively larger than all the other variables. Apart from being statistically significant, both empirically have a more significant impact on sales than the other variables.

Regression coefficients	Method1 - Traditional Model			Method- Willingness to Pay			
	Coefficient	Std Err	p-value	Coefficient	Std Err	p-value	
	Log(Price)	-2.283	1.194	0.061	-36.848	11.506	0.002
	Log(Price-1)	3.204	0.513	0	1.876	0.653	0.006

Looking at Period 1, Method 1 postulates, *ceteris paribus*, a percentage decrease in the effective price would magnify sales exponentially by 2.283. This is consistent with the downward sloping demand curve one expects for normal goods.

The effective price from the previous draw has the opposite effect due to its sign and its coefficient is larger. If the effective price were to stay constant week after week, the net value of the two variables' coefficients $(-2.2 + 3.2)$ would be 1, positive one, implying an upward sloping demand curve since a 1% effective price increase would result in 1% improvement in sales. At this stage there was still room for price to be increased without adversely affecting sales.

The upward sloping demand curve is consistent with theory where goods with network externalities have been shown in the literature review to have an upward sloping demand curve at some point. An upward sloping demand curve occurs infrequently but is documented in economic theory:

- Giffen good is one which people consume more of as price rises, thus violating the law of demand. In the Giffen good situation, cheaper close substitutes are not available. Because of the lack of substitutes, the income effect dominates, with people buying more of the good, even as its price rises.
- Veblen goods are a theoretical group of commodities for which peoples' preference for buying them *increases* as a direct function of their price due to effects such as snob effect, where there is a desire to own unusual, expensive or unique goods, and network effects (or bandwagon effects) where preference for a good increases as the number of people buying the same increases.

Looking at the lottery, it is a legalised monopoly with no close substitutes and, as shown in the literature review, it also exhibits some network externalities or bandwagon effects, as the more participants, the greater the value to each individual player due to higher prize money.

A strategy that could have been executed at this stage would have been to increase the effective Price (not ticket price) by, for example, increasing the takeout rate. This method postulates this could have increased revenue.

Model 2 in contrast to Model 1 showed a downward sloping demand curve, with the coefficient of the effective price of the current draw dominating all other variables at -36.8. The next variable in terms of magnitude is effective Price of the previous draw (Price₋₁) and all other variables are negligible in comparison. The equation then reduces to:

$$\text{Log}(\text{Sale}) = -36.8\text{Log}(\text{EffectivePrice}) + 1.8\text{Log}(\text{EffectivePrice}_{-1}) + \text{Constant}$$

Assuming the same Effective Price for each week for simplicity, the above equation becomes, if we ignore the constant:

$$\text{Sale} = \text{EffectivePrice}^{-35}$$

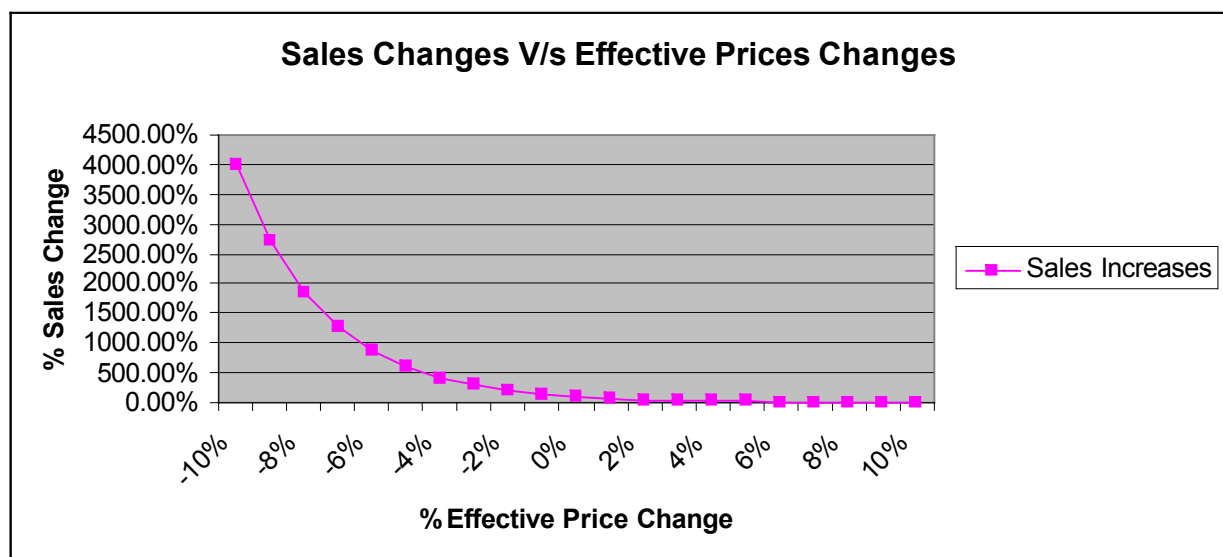


Figure 7 Sensitivity analysis of Sales as a effective Price changes

- Method 2 postulates that Revenue could have been increased astronomically with each percentage drop in the effective Price drop. Figure 7 shows a 4000% increase in sales as a result of a mere 10% drop in the effective price.

Moving to Period 2, based on the numerical value of the coefficients, Effective Price was still the most dominant of all the variables, with both methods showing a downward sloping curve as shown in figure 8.

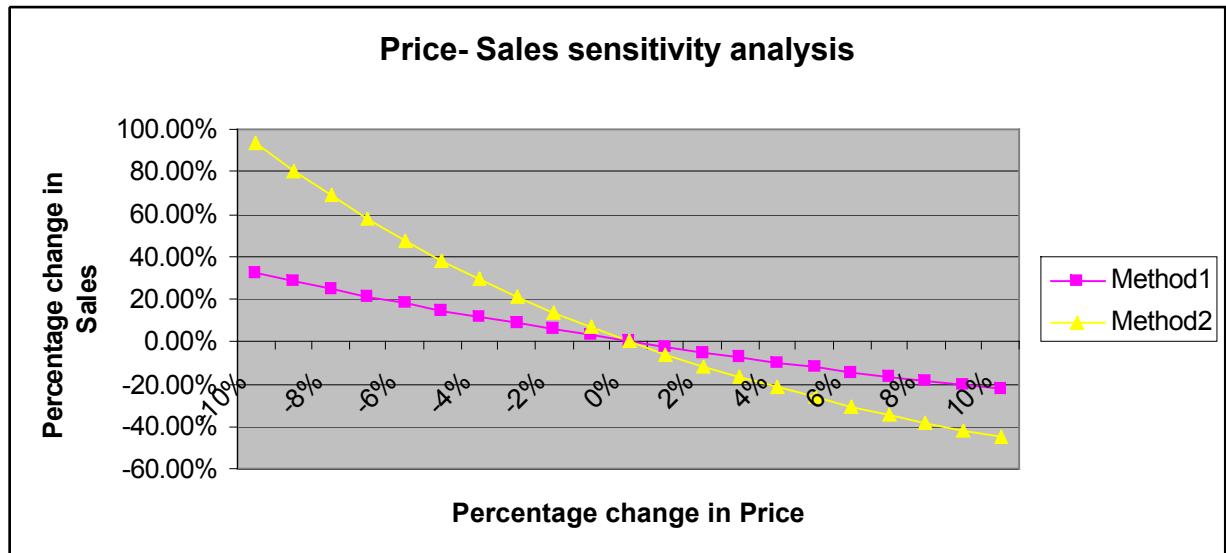


Figure 8 Price Sales Sensitivity analysis for Period2.

Again, a drop in price magnifies Sales with Method 2 showing an increase in Sales of just over 90% for a mere 10% cut in the effective price, showing once more that there was some scope to increase revenue by dropping the effective price.

The Effective Price was statistically insignificant in Period 3 unlike the preceding two periods.

5.1.3 The Trend and effect of Advertising

At the beginning as the lottery increases in popularity, so should revenue, the popularity is expected to increase due to:

- Social proof – to manage risk most people make purchase decisions based on what other people like themselves bought; they look for testimonials to answer the

question, “who bought this product and what happened thereafter?” or look for recommendations or pointers from people they regard as knowledgeable or trustworthy. The lottery operators provide this social proof by publishing the names and sometimes pictures of jackpot winners in an attempt to convey the message that ordinary people like an average bettor can win. This is designed to divert bettors’ attention from the insurmountable odds, to think they too can win.

- Marketing of the games – a lot of advertising spend on aggressively advertising the games in different media types, print, billboards and radio, and a dedicated prime time draw show that is designed to give the lottery an aura of respectability and credibility in contrast to other forms of gambling.

These steps are calculated to make the lottery more profitable as time progresses; however the results depict the opposite as shown below:

	Period 1				Period 2				Period 3			
	Method1		Method2		Method1		Method2		Method1		Method2	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Trend	0.002	0.264	-0.005	0.057	-0.001	0.143	-0.0006	0.2845	-0.0012	0	-0.0012	0
TrendSq	0	0.664	0	0.029	0	0.253	0	0.5534	0	0	0	0

The Trend and Trend² are mostly statistically insignificant for the three periods. Where they are significant the coefficient is zero or a very small negative number close to zero. Although user and lottery fatigue are expected to set in over time, as shown by the negative coefficients in Period 3, the Trend and Trend² were expected to have some impact at least in Period 1 and/or Period 2. That they do not unfortunately indicates inadequate or ineffective advertising impact.

5.1.4 Rollovers

Rollovers are used for primarily for two reasons:

- They stimulate sales as the higher the jackpot, the more regular bettors spend in a effort to improve their chances, and occasional players are lured by the increased prospective price money.
- Farrell et al. (2000b) showed that the effect of rollovers lasts up to five draws following the rollover.

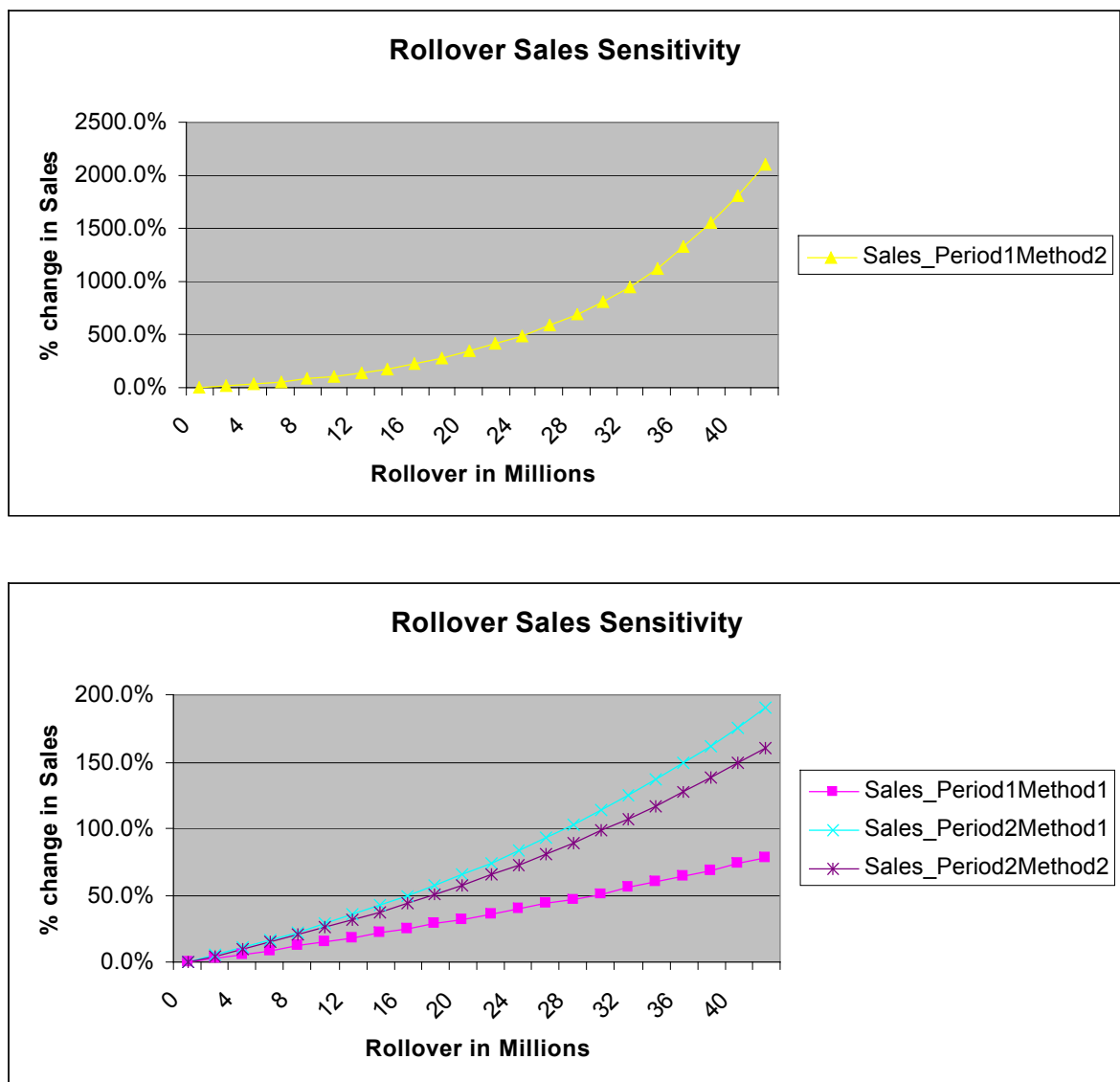


Figure 9 Rollover Sales sensitivity analysis.

As expected, rollover is significant for all methods for all three Periods studied except method 1 in Period 1 where the Rollover marginally missed the 10% confidence interval cutoff.

Figure 9 graphically shows the impact of Rollover on Sales. The noticeable upward sloping curve is testament to the fact that rollovers are important to break monotony of the game; sales would drop by 50% every three years if rollovers are eliminated (Farrell et al. 1999b).

On the other hand, if the game is difficult to win, thus ensuring regular rollovers, bettors would defer their bets until the rollover were sufficiently large for them to play heavily. The end result would be movement of potential sales from one week to the next without necessarily increasing sales, but definitely requiring relatively more infrastructure to handle the increased load. Secondly, a rollover attracts not only casual players but also entices regulars to bet more heavily, thus increasing the likelihood of not only having a winner, but multiple winners, who will have to share the prize money: the less the prize money received, the less attractive the next jackpot is likely to be perceived.

The games should be designed, continuously monitored and updated to balance against these two, sometimes conflicting, consequences of the frequency of rollovers, which is itself a random event making it difficult to manage.

In the studies of three Periods, the lottery operator was not actively managing the rollovers, or at least the management was not visible from afar.

5.1.5 Complements and Substitutes

As shown below for the results between the two methods for all the Periods, the current and Lagging Sales tend to complement each other more than being substitutes.

	PERIOD 1		PERIOD 2		PERIOD 3	
	Method1	Method2	Method1	Method2	Method1	Method2
Sales _{.4}	Compl	N/A	Compl	Compl	Sub	Sub
Sales _{.3}	N/A	N/A	Sub	Sub	N/A	N/A
Sales _{.2}	N/A	N/A	Compl	Compl	N/A	N/A
Sales _{.1}	Compl	Compl	N/A	N/A	Compl	Compl
SaleLP					Compl	Compl
SalesLP _{.4}					Sub	Sub
SalesLP _{.3}					N/A	N/A
SalesLP _{.2}					N/A	N/A
SalesLP _{.1}					Compl	Compl

Compl = Complement and Sub = Substitute.

The past immediate Sales (Sales_{.1}) consistently stayed a complement for the entire period under investigation, which is counter intuitive in that one would expect perhaps a large sale in a particular week to negatively affect the subsequent, because there is a finite amount of disposable income that a bettor can allocate to a lottery per month. This may indicate, however, that some bettors may be returning their winnings from the past week as a bet for the current week. It may also be capturing the effect of the rollover that seems to affect sales for a few weeks after the rollover (see Rollover discussion).

While both Sales_{.1} and Sales_{.3} would have been conducted on the same day of the week for the biweekly draw, the former is a complement and the latter is a substitute in Period 2 where it is statistically significant. For a Saturday draw, this would be the Sales on the previous Wednesday. For a Wednesday draw, that would be the draw on the Saturday two weeks previously. One would expect, considering most lowly paid employees are usually paid every two weeks on a Friday, weaker sales on Wednesday and Week 2 and Week3.

5.1.6 Which of the two Methods is better?

Method 2 is a better fit with better stats all round. The second and third moments were linearly correlated in all the tests resulting in only one of them being used. The coefficient of effective price came to a massive of -36, which appears suspect.

The benefit derived from using Method 2 is minimal and therefore probably not worth deviating from the tried and tested traditional model.

6 CONCLUSIONS

Has the lottery board fulfilled or partially fulfilled its mandate? The lottery board has managed to increase revenue at a rate that far exceeds the income growth of the population or the inflation rate, all this against the backdrop of rising food prices. It has also succeeded in keeping bettors interested in the game even after the novelty had abated by introducing new games and also increasing the regularity of consumption.

The games introduced were found to be complements for the most part. The rollover and possibly a few interventions with a super bonus stimuli on Wednesdays of Week 2 and Week 3 (when sales are expected to be the lowest) could have improved sales figures a bit. There was, however, also room to increase the effective price, an option not exercised.

In summary the lottery board did all the things right; however the more pertinent question should be, did they do the right things? In other words, did the lottery board provide just management skills, or did they provide leadership? To answer the question, one needs to step three steps backwards:

- Their mandate was to collect maximum revenue for good causes (mainly the poor). It was not specified from whom they should collect: in other words the target market was not defined for them.
- Only 22% of the revenue collected trickled down to good causes, mainly the poor and destitute.
- If the general population is targeted, studies have shown that disproportionately more of the players attracted would come from the less privileged and vulnerable members of society (Walker, 1985), people with less formal education, low income earners, black and old people.

The question is posed, is it conceivable that a pro-poor ANC government would setup an agency to collect money from bettors who are poor and vulnerable themselves, just to give back 22% of these funds to another group of poor and destitute people? Considering relatively well off people, such as the distributors (with 5% cut on revenue collected) and the operator who take a cut, is the body of poor people taken as a group

not relatively worse off after playing the lottery than would have been the case if they did not?

If one looks at the ANC (2007) strategy and tactics document, a highly regarded document perhaps only second to the freedom charter, it specifies as its best element “a system that places the needs of the poor high on the national agenda”. A South African deputy minister (Padayachie 2004) is on record as saying in a budget vote, “attacking poverty ... lies at the heart and centre of all of Government's policies and programmes”, and he went on to say that attacking poverty is the first priority of the democratic government. It stands to reason therefore that the government probably expected the previously advantaged members of society as well as the affluent to participate in the lottery to a degree higher than currently is the case. It is then, and only then, that redistribution of wealth might occur, as envisaged in the same strategy and tactics document where the government objective was articulated as being to “pursue economic growth, development and redistribution so as to achieve a better life for all”.

The timing of introducing the LottoPlus also coincided with an above inflation rise in basic food prices in South Africa resulting in less money available for the lottery especially from the poor – the regular players. There was no deliberate attempt to target a different market segment with the second game nor was there a noticeable shift in distribution channels to realise the agenda to redistribute wealth, e.g.

- One is yet to see a lottery machine at Woolworths where the affluent shop.
- For the younger generation, and the young at heart, a lottery presence through MiXit, Africa's biggest online instant messaging service, would have been “a cool place to be at” – as the youth would eloquently and succinctly put it.
- There was no electronic or online means to participate in the lottery until FNB took the initiative recently, and one still cannot not play the lottery using mobile phone as a channel.
- Educated people are aware that random numbers are required to win the lottery; however, there is still no random number generator available for use, unlike in first world countries.
- An affluent person may be inclined to attempt to maximise return by playing number combinations that no one else has played to ensure not having to share

the prize money in case of a win. This type of person may require prior knowledge of what other bettors have not chosen. Perhaps making it possible to verify one's choice of numbers on a website to confirm how many tickets have also chosen the same combinations, should be considered.

- An educated person will be fully apprised of the minuscule odds of winning; it may be a good idea to consider the feasibility of facilitating syndicate betting to improve the odds as a value proposition or introduce games with better odds.

Some may argue the point that the affluent do not have a need or the appetite for gambling, but the following examples indicate otherwise:

- The Vodacom “100 cars in 100 days” competition was a resounding success until stopped by the lottery board's legal action. The board viewed it as a game of chance which only the lottery board is legally empowered to run. The competition involved sending an SMS and the person who sent the most SMSs in a particular day was declared the winner.
- The First National Bank's R1 Million a month competition was also a phenomenal success, until also stopped by the lottery board. It involved depositors depositing money into a zero interest bearing account, and for every R1000 deposited, the depositor got one entry into the monthly R1 Million draw. The interest forfeited was used to finance the R1 Million monthly prize.
- Bid or buy type auctions, where say a new R100 000 worth car is made available. By paying R100, the first 2000 players would choose a number between 1 and 500; whoever chooses a unique number not chosen by any other player wins. The operator is always guaranteed a handsome profit for facilitating this little game between players.

Players in all the above were middle to high income earners. The lottery board legally blocked other players from doing what they themselves are legally mandated to do but chose to concentrate elsewhere where revenue margins are under pressure. The fact that there was no notable decrease in lottery revenue around the time the Vodacom and FNB competition ran, and equally there was no increase in lottery revenue when these were stopped, would suggest the time games operated in different market segments.

7 RECOMMENDATION

It is recommended that the Lottery board consider the following:

- Instead of the lottery board closing down potential competitors that show initiative, such as FNB and Vodacom, they should consider subletting their licence and collecting revenue at virtually no cost or effort on their part. The board should recognise that they do not hold a monopoly on lucrative gambling ideas nor do they have the infrastructure and know how to support some of the ideas. What they do have is a monopoly licence to operate a game of chance. Instead of thwarting or frustrating competing ideas these should be left to blossom and actively encouraged with a view to extracting additional revenue from them.
- Introduce new games aimed at a different, more affluent or youthful, market, with special attention paid to the branding and positioning to differentiate it from the other lottery games, mainly for two reasons: Firstly, the current games are associated with non sophistication on the players' part and the new affluent players may be extremely reluctant to be associated with the current crop of players. Secondly, it should be also be borne in mind that the more affluent population would have a disproportionately greater representation of white people, who are most likely to treat anything from government or its agency unfavourably or with a lukewarm response. It is important that these new games are at arm's length from government and the branding and communication strategies should emanate from a source that would appear credible to this target market. Griffiths and Woods (1999) give two reasons for manufacturing the credibility in lottery games.
 - (a) It leads to processing of messages in half minded state, either because the person is not motivated to think, or does not have time to consider, or lacks the ability to understand issues.
 - (b) Source credibility stops questions: if it is such and such a company that has a good association with backs it, then it must be right.

- Some thought needs to be given to the distribution channels of the new game to fit the lifestyle of the target market, members of which would for instance be more inclined to play a game that requires them to SMS their number selection privately, than one where they would stand in a long winding queue outside a supermarket.
- It is also recommended that the games to be introduced should consist of one continuous game supported by few games with shorter lifespan such as 100 days where 100 BMW are up for grabs. This should keep the hype going as new games are introduced.
- Partnering with other providers to offer lottery as some kind of combo products, to use a simple example, buy a McDonald burger could get one a free lotto ticket.

8 AREAS FOR FURTHER RESEARCH

Mechanical draw machines are used for the draws, with the balls inserted in a particular predefined order as pointed out in Koning and Vermaat (2000); the balls' weights are also not 100% the same, and the timing of the auditor to signal for the start button to be pressed etc., make it possible that some numbers would be more likely to be drawn than others. Lottery regulators in first world countries periodically check that the winning numbers are drawn randomly, as highlighted in Percy (2006). These checks involve physical checks of mechanical draw equipment, supervising and verifying conduct of draws, and lastly a statistical analysis is conducted to assess the randomness of the numbers drawn. A statistical study by Bellhouse (1982) demonstrated that the Canadian lottery materially deviated from expected statistical outcomes. According to Bolland and Pawitan (1999), Morgenstern (1979) was the first scholar to write on equi-probability of lotto numbers, followed three years later by Henze (1982), then Stern and Cover (1989) and later Joe (2003). While it is plausible that the South African lottery board may have conducted these tests for their own consumption, it is crucial for an independent credible source to undertake the research to identify bias if it exists, and generally champion the public cause of ensuring that no one is unfairly advantaged or disadvantaged, intentionally or by omission.

The study showed that more revenue was collected in some weeks of the month than others, with a major drop in revenue expected in Week 2 and Week 3 of the month. The effects of rollover on Sales were shown, and lastly it was also shown that Sales are generally lower on a Wednesday than a Saturday. The question is: if the operator chooses to introduce a super draw, what would be the best week, the best day (Saturday or Wednesday) to do so, and lastly by how much would Sales be expected to increase?

It is also worth investigating how much of the prize money won in the current week is returned in subsequent week(s), firstly to assist in lottery design and planning, and secondly to inform the prize payout policy. The more money returned as a bet for the following week, the more streamlined the payout process should be.

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