SPORTS GAMBLING AS CONSUMPTION:
AN ECONOMETRIC ANALYSIS OF DEMAND FOR SPORTS LOTTERY

By

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To my family and friends for their unwavering support and encouragement over the years

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LIST OF ABBREVIATIONS

CSLAC	China Sports Lottery Administration Center
CWLDMC	China Welfare Lottery Distribution & Management Center
GBGC	Global Betting and Gaming Consultants
GGY	Global Gambling Yield, gross bets minus winnings payments
NGISC	National Gambling Impact Study Commission
PASPA	Professional and Amateur Sports Protection Act of 1992
UKNL	United Kingdom National Lottery

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Despite that sports lottery gambling has become a prevalent economic and recreational activity, it remains an under-researched area in sports management literature. Based on Conlisk's (1993) theory on the utility of gambling, an econometric model of demand for sports lottery gambling was constructed and examined in this study. The model assumes an experiential utility associated with sports lottery gambling, and proposes that rational consumers are mainly motivated by three clusters of variables: product attributes, consumer demographics, and marketing variables. The model is empirically examined by using a set of draw-to-draw sales data (from 2001 to August 2012) of the *Shengfu* game, the most representative sports lottery in China. Through time-series and panel data analyses, this study has the following major findings: (a) sports lottery has consumption value for players, for which ticket composition has considerable impact on the demand. Draws composed of popular leagues and tournaments are often associated with higher demand; whereas, draws composed of smaller leagues often sell less; (b) consumers are sensitive to the implicit cost of a buying lottery ticket (i.e., effective price), where the estimated effective price

elasticity is around -1; (c) at least in the context of Chinese sports betting market, the province with higher income level had higher demand for sports lottery, contradicting the regressivity property of traditional lottery games. The estimated income elasticity is around 0.4; (d) consistent the research findings of previous studies, population segments with higher financial and social burdens tends to buy more lottery tickets; (e) marketing variables and structural arrangements of the game were found have significant impact on consumer demand of sports lottery tickets; (f) consumers showed signs of learning from betting experience and increasing the odds of winning as evidenced by an ever increasing median probability of winning the first and second prizes; and (g) population, education level, sport development, and venue accessibility were found not significantly related to the demand of sports lottery.

CHAPTER 1
INTRODUCTION

Significance of Sports Gambling Industry

> The next best thing to a fortune is the chance of a fortune… To purchase a ticket in a lottery, indeed, is to buy a kind of fiction in which oneself is the hero.
>
> – Chance, New Statesman and Nation, June 6, 1931.

Both gambling and sports are ancient and ubiquitous. People flock to casinos, horse tracks, and betting shops. People play and spectate sports in droves. The magnitude of dollars involved in gambling is staggering - 2.6 trillion U.S. dollars were spent in 2007 worldwide (Morss, 2012). The forms of legal gambling are various, including lotteries, bingo, casino, and sports gambling. Most Americans have participated in some form of gambling whether it involves purchasing a lottery ticket, playing fruit machine, placing a bet at the track, or making a bet with friends in an office pool (Welte, Barnes, Wieczorek, Tidwell, & Parker, 2002). As staggering is people's passion about sports; for instance, the top four professional leagues in North America, National Football League (NFL), National Basketball Association (NBA), National Hockey League (NHL) and Major League Baseball (MLB), collectively bring in about 24 billion U.S. dollars in revenue during a typical year, which is just the tip of the iceberg. The estimated sport business scale in the United States alone is worth between 400 to 435 billion U.S. dollars (Plunkett Research, 2012).

What ties gambling and sports together is that people like betting on the outcome of sporting events. Apart from forerunners in ancient Rome and Greece, organized and sanctioned sports betting dates back to the late 18th century, when modern bookmaking and pari-mutuel systems came into being (Munting, 1996). Today, the proliferation of modern technology in the sport arena has further contributed to the growth of gambling participation (Claussen & Miller, 2001). Although representing only 2.6% of the legalized gambling market, sports gambling has become the fastest growing gambling segment, with an annual growth rate of 14.7% in the past five years (AAP News, 2012). For instance, in the United States where bookmaking is only legal in Nevada and certain forms of sports lotteries in Oregon, Delaware, and Montana, sports gambling represents 9.86% of the sports industry (Zhang & Cianfrone, 2011). In 2011, 2.88 billion U.S. dollars were legally waged in Nevada's sports books, representing less than 1% of all sports betting in U.S. Approximately $93.9 million was wagered on the Super Bowl in the state's sports books in 2012 according to the Nevada Gaming Control Board, and the event earned a net income of $5.1 million for the Nevada sports books (American Gaming Association, 2012). During the 2010–2011 fiscal year, the British gambling industry generated a gross yield of £5.5 billion, where the sports betting sector had the largest market share within the sports industry, accounting for 53% of all gambling transactions (Gambling Commision, 2012).

Regardless of its relatively short appearance in the world gambling and sport business milieu, China has achieved rapid developments in both industries. The average annual growth rate of the sport industry has been about 20% or higher in recent years. In 2008, the sports industry realized a total transaction value of $22.87 billion, accounting for 0.52% of China's total GDP (Li et al., 2012). The last two decades also witnessed a gradual open-up of China's gambling market. Yet, the only legal form of gambling in China remains national lotteries, which are administered by two national agencies: China Welfare Lottery Distribution and Management Center (中国福利彩票发

行管理中心, CWLDMC) and China Sports Lottery Administration Center (中国体育彩票管理中心, CSLAC). Since the inception of the first national lottery in 1987, the lottery gambling market has been growing rapidly in the past 25 years. The entire market reached to 221.6 billion *yuan* (about 35.1 billion U.S. dollars) in 2011, representing a 33.3% annual growth. The sales of CWLDMC lottery reached127.8 billion *yuan,* making a net revenue of 39 billion *yuan*; and the sales of CSLAC lottery reached 93.8 billion *yuan*, making a net revenue of 25.3 billion *yuan* (Ministry of Finance, 2012). Almost all mainstream lottery schemes, including lotto, numbers game, instant games, and high frequency lotteries are now administered by both centers, however the sports lottery are only available from the CSLAC. Sports lottery provides a niche market for the CSLAC. In 2011, the sales of the sports lottery climbed to about 21.8 billion *yuan*, representing 23% of the CSLAC lottery market and 10% of China's lottery market (Ministry of Finance, 2012). China's sports lottery, however, is not an entire innovation. Its counterparts can be found in other countries, such as the Sports Select in Canada, La Quiniela in Spain, Football Pool in UK, and the Delaware sports lottery in the U.S.

Need for Empirical Demand Research

The burgeoning of the gambling and lottery industry is puzzling. Gambling is a zero-sum game. Gambling market in general cannot simultaneously yield profits for both sides of gambling participants (Sauer, 1998). Lottery market is even worse. With a higher take-out ratio compared to other forms of gambling and an extremely low probability of wining, the average expected return on one dollar lottery ticket is between 40 and 60 cents (Thaler & Ziemba, 1988). Lottery tickets are evidently a type of "negative asset", and usually a poor investment for any rational economic agent whose goal is to maximize their expectation of return. Yet, people continue to buy lotteries, in droves anyway, violating the standard economic assumption of rationality and risk-aversion in human behavior (McCaffery, 1994; Quiggin, 1991). Furthermore, the coexistence of gambling and insurance purchase constitutes a paradoxical phenomenon that has attracted much scholarly interest. Scholars working in the separate disciplines of psychology, economics, sociology, and among others have explored the phenomenon. This has led to two broad categories of explanation: rational vs. irrational. The stream of rationality of playing lottery has focused on the consumption value of lottery play (Conlisk, 1993; Forrest, Simmons, & Chesters, 2002), lottery play as motivated by indivisibility in expenditures (McCaffery, 1994; Ng, 1965), and lottery play as a means to gain “something for nothing” (Nyman, Welte, & Dowd, 2008). The stream of irrationality has largely drawn on the Prospect Theory (Kahneman & Tversky, 1979) and cognitive theories of gambling (Rogers, 1998), maintaining that lottery play is out of ignorance or cognitive error of the players.

Nevertheless, empirical investigations of the demand for lottery products in the economics literature explicitly or implicitly adopt a paradigm based on the expected utility theory. They have examined the demand for lottery products empirically from either of two perspectives: a source of public revenue or a consumer commodity (Clotfelter & Cook, 1990). Since public lotteries were introduced as a way to increase governments’ budgetary income, and the takeout of lottery revenues can be regarded as an implicit tax levied on the players, a line of research examines the economic and social implications. The main empirical questions arising from this perspective are the estimation of income elasticity of demand (i.e., whether this lottery tax is progressive, neutral, or regressive) to assess the impact of lottery tax on the relative distribution of income among the population (Clotfelter, 1979; Garrett & Coughlin, 2009; Ghent & Grant, 2010; Spiro, 1974), and the estimation of own-price elasticity of demand to assess whether the price or takeout rate is optimal to maximize revenue (DeBoer, 1986; Forrest, Gulley, & Simmons, 2000; Gulley & Scott, 1993). The main empirical questions arising from the later perspective are whether consumer demand for lottery games responds to true expected returns, as maximizing behavior predicts, or whether consumers seem to be misinformed about the risks and returns of lottery game, and what factors to be included in the estimable demand functions. These works may be divided into those who used product attribute variables, such as effective price, jackpot, and prize structure (Forrest et al., 2002; García & Rodríguez, 2007; Scoggins, 1995), those who used consumer characteristic variables, such as income, gender, age, education, religion, and ethnicity (Felsher, Derevensky, & Gupta, 2003; Herring & Bledsoe, 1994; Walker, Courneya, & Deng, 2006), and those who used marketing variables, such as venue accessibility (Hing & Haw, 2009), cross border competition, and product substitution (Forrest, Gulley, & Simmons, 2004; Garrett & Marsh, 2002), and social responsibility marketing (Li, Zhang, Mao, & Min, 2011).

The purpose of demand analysis is to explain the process by which a consumer makes choices to maximize the utility he or she can derive from selecting the best possible combination of commodities within the budget constraint (Clarkson, 1963). Traditional demand analysis starts with an underlying utility function. Whereas utility itself involves no psychological interpretation, it is supposed to describe consumer's preferences and rationalizes that demand behavior (Varian, 1992). The theory of demand evolves with the debates centering the fundamental assumption of rationality in human behavior, and has been gradually given much behavioral interpretation (Becker, 1962; Domencich, McFadden, & Charles River Associates., 1975; Zhang, Lam, & Connaughton, 2003a; Zhang, Lam, Williamson, Braunstein, & Ellis, 2003c). Market demand is regarded as consumer expectations towards the main attributes of the core product (Zhang et al., 2006; Zhang, Lam, & Connaughton, 2003b). Demand analysis in terms of product features, consumer characteristics, and marketing environment is essential to develop a product that can deliver values to the consumers; demand analysis in terms of consumer characteristics is fundamental to segment consumers; demand analysis in terms of marketing variables can facilitate the formulation of marketing plans and forecast of sales (Kotler & Keller, 2009). In lottery gambling literature, the insights from demand studies thus far have been consequential. The extant evidence suggests that lottery participation rates and levels of lottery purchases are strongly influenced by the effective price and the jackpot. Furthermore, the results from previous studies indicate that the heaviest lottery players are poor, young, and uneducated single men who live in urban areas and belong to specific minority (African-American and Hispanic) and/or religious (Catholic) groups.

Statement of Problem

There is apparent paucity in research on sports lottery gambling. Conceptual and empirical investigation of this topic has been limited to a very small number of studies, for example, Forrest and Simmons (2003) made a case of the symbiotic relationship between gambling and sport; Smith (1992) documented the development of sports lottery in Canada; Claussen and Miller (2001) made a conceptual arguments about the driving forces of sports gambling in the U.S.; and García and Rodríguez (2007) and

García, Pérez, and Rodríguez (2008) tested the demand for football pools in Spain. There is thus far a wide gap between theory and practice with regard to sports lottery.

Sports lottery comes into being as a compromise between traditional lottery games and sports betting. Arguably a form of lottery, sports lottery differs from traditional games in several critical aspects. The first difference is in the non-randomness of the drawing. All traditional lotteries that share the characteristic of random selection of winners without any intellectual factor, such as skill and knowledge, associated with picking a winning ticket (Mikesell & Zorn, 1987). In contrast, sports lottery has no well-defined objective probability of winning. Information and knowledge players have about the sport teams, such as competition records, competence of the coach, and performance of the players, may influence one's winning probability. It has been shown that the probability of winning a grand prize by correctly forecasting the completion results of all matches in the parlay is much higher than the probability if the competition results were completely random (García & Rodríguez, 2007). It is exactly because of its non-randomness in determining a winner, the Football Pool in the UK is not regarded as a component of its national lottery system (Munting, 1996). The second difference is in knowledge-based reasoning and over-confidence. Relating to the nature of sports gambling, players tend to rely more on their background knowledge of the sport than evaluation of risk dimensions (e.g., probability of winning and pay-out rate) in their lottery ticket purchasing decision (Ranyard & Charlton, 2006). Moreover, sports fans often consider themselves as experts. Due to simplistic nature of various sport competition forms along with their familiarity and interest of sports, sport gamblers often feel they have superior expertise and intelligence in beating the prediction odds. This over confidence would likely carry over to their lottery purchase decision, and may also induce stronger wishful thinking than what has been found in traditional lottery games. The third difference is related to the experiential utility in sports gambling. Sporting events are emotionally charged and the final result of a game means much to a real sports fan. For a loyal fan, sports gambling may be used as a way to express their allegiance with their teams or hedge the potential disappointment and sadness in case of lose (Koning & van Velzen, 2009). Therefore, sports lottery consumption shares some commonality with spectator sports consumption. Some fan attributes that influence spectator sports demand, such as the quality of teams, were shown to have a positive and significant effect on the volume of bookmaker betting in the U.S. (Paul & Weinbach, 2010) as well as the demand for sports lottery in Spain (García, Pérez, & Rodríguez, 2008). Finally, the sports lottery market may be inherently heterogeneous. Besides sports fans, there are also fans of sports gambling and professional sports betters, who have much less passion attached to any individual teams and cares more about the monetary gain (Delaney, 2007). This inherent heterogeneity in different customer segments may lead to different demand function for sports lottery.

Much of the knowledge gained from lotteries has been conducted on lottery games in the U.S. and in the U.K. There have been no studies that provide any empirical analysis on lottery games in China. Hsee and Weber (1999) found that Chinese people were significantly more risk seeking than Americans in investment decisions. This risk preference likely carries over to Chinese lottery gambling decisions. Moreover, the Friedman-Savage (1948) utility function, elaborated upon expected utility theory, argues that utility in a specific segment of wealth is increasing. The ambition of social improvement and dream of moving up into a higher class is a key motivation behind lottery gamblers. This dream can arise from socio-economic inequalities, and lottery gambling was found to be more frequent and intense in countries with more acute social inequalities (Kaizeler & Faustino, 2008a). China is one of these countries with the GINI index estimated at around 0.47 in 2005 (Wang, 2010). A Gini coefficient around 0.5 means the inequality problem is extremely severe. The increasingly widening gap between the rich and the poor in China calls for a critical look at its lottery demand and its implications for China's social and economic reforms.

Furthermore, China has a very unique lottery market structure. Unlike the U.S. and Europe, China has a national lottery market that is highly regulated by the national government. Meanwhile, the lottery market is facing a vigorously dynamic marketing environment with duopoly of CWLDMC and CSLAC, and possible cannibalization of dozens of other types of lotteries. As the market follower, the CSLAC has developed competing lottery products for almost all products currently sold by the CWLDMC. All main types of lotteries, including lotto, numbers, and instant tickets, are available at both the CWLDMC and the CSLAC retailing outlets and terminals. Furthermore, the lottery market is also subject to the threat of cross-border gambling and illegal gambling. The mainland of China is surrounded by many gambling ventures, including casinos in Macau, Malaysia, Vietnam, Laos, Cambodia, and North Korea. Wealthy Chinese gamblers flock to these venues on national holidays and weekends. Gambling also takes place in card and mahjong rooms on street corners and underground casinos in the cities, through unofficial lotteries in the countryside, and on hundreds of websites catering to Internet gamblers. The money wagered on illegal gambling was estimated at least 10 times of legal wagers on national lotteries. The uniqueness of this market offers the potential of greater insight about lottery gambling, for which one could not obtain from previous studies that were based on European or American markets.

Purpose of the Study

The overarching purpose of this study was to examine the market demand for sports lottery in China. The current research had two main foci: (a) to develop an econometric model to estimate the market demand for sports lottery, and (b) to identify and examine the relative impact of three classes of determinants, including product attributes, consumer demographics, and marketing variables. To accomplish these goals, this study focused on the demand for the *Shengfu* lottery game, a soccer betting lottery established in October 2001 and the most popular sports betting game in China. A set of nation-wide aggregate sales data for each draw of the *Shengfu* game from draw 2001001 (October 2001) to 2012110 (August 2012) and a set of provincial level sales data for each draw of the *Shengfu* game from draw 2011001 to 2012110 were be obtained and analyzed through both time series and panel regression modeling.

Significance of the Study

The current study represents an initial effort to explore the demand for sports lottery gambling in China, a fast-paced developing country with enormous demand and a more sophisticated gambling market with dozens of national lottery products. The research findings from this study have contributed to fill a void in the sport management literature by first developing an econometric model for the demand for sports lottery, and then testing the model based on a unique set of draw to draw data. Gaining an in-depth understanding of the demand for sports lottery would help lottery consumers make more informed and rational decision choices, facilitate the governing bodies to make more sensible decisions regarding the sanctioning of gambling products, and enable sports lottery agencies to allocate their resources toward optimizing their product portfolio. Furthermore, knowledge of sports lottery may also make a humble contribution to the growing gambling literature in general. This study is timely, when several countries and U.S. states, including India and New Jersey, are considering legalizing sports lottery. The findings of this study certainly can lend some evidence for legislators to consider.

Delimitations of the Study

As the focus of this study was on the aggregate market demand for one type of sports lottery, namely the *Shengfu* game, in mainland China, this study had the following delimitations. First, this study focused on aggregate demand and had recourse to the theories of rational expectations to model the utility of sports lottery gambling. The units for data analyses were 30 provinces in China. This study did not intend to model the consumer demand on an individual level. A model of individual demand for sports lottery would call for a different theoretical framework, require micro data, and perhaps involve a different set of explanatory variables. Second, this study only considered the *Shengfu* game, not other types of sports lottery. The game is the oldest and most representative lottery of its kind in China, and resembles many important characteristics of other sports betting products available in other countries, such as Sport Select, La Quiniela, and Delaware Sports Lottery. The empirical findings of this study may be revealing to other games of similar characteristics, but may not be directly applicable to other games with different characteristics. Third, this study focused on China's lottery market. The findings of this study may be unique to the context due to the different development political, economic, and social factors of China.

Definition of Terms

BETTING POOL. A type of betting system in which players pay a fixed entry fee into a pool to make a selection on some outcomes, and the pool is shared by winners between those who have made the correct selection.

BOOKMAKING. A type of betting system in which bookmakers post odds and charge a commission for placing a bet on the outcome of sporting events, political contests, and other competitions. In this system, bettors are promised a fixed payoff according to the odds posted at the time of making their bets (Chung & Hwang, 2010).

CSLAC LOTTERY. Known as 'Sports Lottery' in China, it refers to any type of lottery administered by the China Sports Lottery Administration Center, including both sports lottery and traditional lottery.

CWLDMC LOTTERY. Known as 'Welfare Lottery' in China, it refers to any type of lottery administered by the China Welfare Lottery Distribution & Management Center. CWLDMC does not have a sports lottery.

DRAW. Also drawing, an occurrence of the process of deciding the winning numbers.

EFFECTIVE PRICE. The cost of buying a probability distribution of prizes that has expected value of one dollar (Clotfelter & Cook, 1987). Effective price of a unit price lottery ticket can be measured by the difference between its face value and the expected value of the prize, which tends to converges to the takeout rate with sufficiently long periods of time (Gulley & Scott, 1993). An alternative expression of effective price is the inverse of the expected value of the prize (Garrett & Sobel, 2004).

GAMBLING. Various types of wagering activities involving material gains (losses), with consciousness of risk and hope of gain, on the outcome of an event whose result may be determined by chance or accident or have an unexpected result by reason of the better's miscalculation (Encyclopædia Britannica, 2012). It involves consideration, chance, and rewards (Rychlak, 1992).

JACKPOT. The highest prize in a lottery game. Jackpots are paid either in annuity payments or in one lump sum.

LOTTERY. Traditionally, a lottery is a game of chance rather than a game of skill whereby winners are chosen by some random selection process. The most popular forms are Lotto, numbers games, and instant games. It may also refer to a game of skill, such as sports lottery.

LOTTO. A type of lottery game involving a selection of number combinations to be purchased by lottery players. Lotto games offer players the possibility of winning very large sums of money.

PARI-MUTUEL BETTING. A type of betting system in which the payout from a specific outcome is inversely related to the aggregate amount wagered on that outcome relative to the aggregate amount bet across all outcomes (Chung & Hwang, 2010).

PARLAY. A single bet that involves two or more individual wagers and is dependent on all of those wagers winning together.

PRIZE POOL. The total amount of money that is available to be divided among the winners in a lottery game or drawing.

ROLLOVER. The rolling over of an unallocated prize pool from previous draws to successive draw in a lottery system.

SPORTS LOTTERY. A form of lottery involves bets on the results of preselected sports events. Sports lotteries are popular lottery games in much of the world, where they are frequently called ‘Sports Lottery’ (China, Delaware), ‘Toto’ or ‘Totocalcio’ (Italy), or ‘Football Pools’ (UK). In North America, sports lotteries are available in Canada and the state of Delaware.

SPORTS BOOK. An establishment that accepts wagers on sporting events.

WAGER. A wager is to have risked money, or something of value, on the outcome of an event.

CHAPTER 2
REVIEW OF LITERATURE

Despite of the prevalence of sports lottery gambling in modern society, there is a paucity of research specifically addressing the issues related to the consumer demand for this type of gambling product. Instead, various streams of research in gambling, lottery, and sports betting proffer a broad foundation to analyze the economic principles underlying the sports lottery industry. This chapter begins with a brief survey of the concept and characteristics of gambling and lottery, and the germination of sports lottery, followed by an overview of sports lottery operations in China. Next, I reviewed the theory of demand and the utility of lottery gambling, focusing on the Expected Utility Theory and its derivatives. Then, I present a review of the econometric models of market demand for gambling products with an aim to identify influential factors of sports lottery demand to be empirically tested in this study.

Gambling, Lottery, and Sport

Gambling

Gambling is an ancient and ubiquitous recreational activity worldwide and peculiarly difficult to define. It has a wide variety of incarnations, ranging from such informal pastime as matching fingers and rolling pebbles, to such institutionalized chance games as lotteries, horsing racing, sports betting, and casino games (Bloch, 1951). In some casual writings it may broadly refer to any area of risk or chance where some material gain (loss) is involved, including stock market speculation, and investments on some financial derivatives. All gambling seems to dwells on the chance factor of success for its participants, but differs from market speculation in that gambling itself does not determine or influence the outcome of the event (Munting, 1996).

Theoretically, the amount of betting will not make a horse run more or less slowly; the volume of gambling will not affect the performance of the sports teams on field, or the probability of winning a prize over the slot machines. By contrast, in the case of speculative market, the aggregate effect of demand on a particular share is to determine the price. A consensual and narrower understanding of gambling will include various types of wagering activities involving material gains (losses), with consciousness of risk and hope of gain, on the outcome of an event whose result may be determined by chance or accident or have an unexpected result by reason of the better's miscalculation (Encyclopædia Britannica, 2012b). Rychlak (1992) succinctly concluded that all gambling relates to three elements: consideration, chance, and rewards.

Gambling has huge consumer demand and is indeed a big industry in the world. Bloch (1951) argued that human beings in modern society are motivated to gamble in an attempt of escaping from the routine and boredom characteristic of modern industrial life. It is a type of entertainment, likening to movies, spectator sports, or other plays. From labor supply market perspective, Nyman et al. (2008) suggested that people escape from daily work for gambling because the gain from gambling is additional income for which the gamblers do not need to work. The Global Betting and Gaming Consultants (GBGC, 2007) estimated that the Global Gambling Yield (GGY), defined as gross bets minus winnings payments, was 337.1 billion U.S. dollars in 2007, with casino being the primary vehicle for gambling and representing 32% of market shares. North America (120.1 billion U.S. dollars) and Europe (102.5 billion U.S. dollars) generated the most gambling revenue with Asia and the Middle East (75.6 billion U.S. dollars) in third place. The United States, with 94.9 billion U.S. dollars revenue, is the leading country in worldwide gambling market. The major types of gambling in the United States now includes casinos (traditional, tribal, and riverboat), pari-mutuels (horse, greyhounds, jai alai), state-run lotteries, bookmaking (sports, horse), card rooms, charity bingo and other charity games (Pavalko, 2000; Welte et al., 2002). The global betting totals however are even larger as bettors do not expect to lose all they bet. Using GGYs as if the "institutional take-out", it is estimated that the global bets in 2007 were 2.6 trillion U.S. dollars (Morss, 2012).

Lottery

Lottery is a major player in contemporary global gambling milieu. Its contribution to the GGY reached 98.3 billion U.S. dollars in 2007, second only to casino (GBGC, 2007). The worldwide sales of lotteries are estimated to amount to 224.3 billion U.S. dollars in 2007 (LaFleur's 2008 World Lottery Almanac, cited in Ariyabuddhiphongs, 2011) and 240.1 billion U.S. dollars in 2009 (LaFleur's 2010 World Lottery Almanac, cited in Scientific Games, 2012a). Lottery is also one of the fastest growing sectors in gambling, growing by 78% in the 1999-2007 period (GBGC, 2007). Lotteries are games of chance, to which the over 100 countries and 200 jurisdictions have recourse for raising general revenues or earmarked purposes (Ariyabuddhiphongs, 2011). In history, it is known that British kings sanctioned lotteries to fund London's water supply, Westminster Bridge, and the British Museum (Munting, 1996). Throughout early American history, lotteries helped to build cities, including the Jamestown settlement, and establish universities by financing buildings on the campus of Harvard and Yale (Clotfelter & Cook, 1990). During the American Revolutionary War, lotteries were even authorized by the Continental Congress to help offset the high cost of the war (Scientific

Games, 2012b). Regardless of its historical significance, lotteries of all kinds were gradually discarded in the nineteenth century as nations developed what are now standard methods of finance and taxation. In the United States, lotteries had been prohibited since 1895 after the outset of the Louisiana lottery scandal (NGISC, 1999). The modern lottery was not introduced to the public policy sphere until 1964, when New Hampshire became the first state to employ lotteries to raising revenue. The lottery expeditiously diffused across the country. New York adopted a lottery in 1966, New Jersey in 1970, and ten more states in 1975 (NGISC, 1999). Today there are lotteries in 41 states plus the District of Columbia. In the United Kingdom, the UK National Lottery was introduced in 1994, which has soon grown into one of the largest lotteries in the world (Forrest et al., 2000).

Lotteries are sold in various forms, the most popular being the lotto, the numbers games (e.g., Pick-3, Pick-5), and instant games (e.g., scratch cards). The prize structure of a game can be organized in a format of fixed-payout or pari-mutuel. For example, the inaugural UK National Lottery was a standard pari-mutuel 6/49 lotto game (Forrest et al., 2000). The buyers select 6 two-digit numbers from 01-49. The jackpot pool is to be shared by all those selecting the six winning numbers. There are also smaller fixed-payout prizes for partially correctness (e.g., 5 numbers in the 6/49 game). If no one selects the full set of winning numbers, a rollover is declared and the jackpot prize money is added to the jackpot pool for the following draw. There are also variants in terms of prize structure. In the case of Chinese Sports Super Lotto, a 5/35 plus 2/12 game, both the grand and second prizes adopt a pari-mutuel format, and there is maximum payout for the grand prize (i.e., 5 million *yuan*) (China Sports Lottery

Administration Center, 2012). Traditional numbers game is similar to a raffle. The players buy a fixed face-value ticket on which the numbers have already printed, and the winning number to be declared in a later time. Today this old-fashioned game is virtually extinct, having been replaced by modern numbers game which apparently requires players' "active" selection of a certain-digit number (Clotfelter & Cook, 1990). Those who pick the winning number will be typically awarded a fixed amount of prize (e.g., 1,000 *yuan* and 10,000 *yuan* for Chinese Pick-3 and Pick-5 game respectively). In instant games, the players scratch the surface of the tickets to reveal the award information. The games have become more complex and have greater intrinsic "play-value" nowadays. Instant games can be analogous to slot machines in casino (Ariyabuddhiphongs, 2011). For example, the Massachusetts scratch cards, with varying cash and non-cash prizes, were priced at different rates: $1, $2, $5, $10, and $20. Prizes vary from card to card but the minimum win is 1 U.S. dollar and the maximum winnable amount on a card is 10 million U.S. dollars. More interesting, some organizations become affiliated with the issue of scratch cards, notable the NBA and MLB. These special cards often offer extra prizes such as a season ticket for life (ScratchCards.org, 2012). In 2011, the China Sports Lottery Administration Center launched a series of NBA theme scratch cards with official authorization of the National Basketball Association. These scratch cards sold out soon after they hit the market. In addition to these three major types of lotteries, many lottery administrations have launched game variants or new games, including high-frequency lottery, new media lottery, and sports (betting) lottery.

Lotteries share common characteristics of all gambling as they involve consideration, chance, and rewards. The consideration component is the fee for a lottery ticket, the chance component is the randomly selected winning numbers, and the rewards component is the lottery prize (Scientific Games, 2012a). Meanwhile, lotteries have three distinctive features in comparison with other gambling forms. The first is the monopoly power of the nation or state. Lotteries provided by the private sectors are outlawed. In the United States, each state has granted itself a monopoly over lottery gambling within its boundaries (NGISC, 1999). In the United Kingdom, the operation of the lottery was exclusively franchised to the private consortium, Camelot group plc (Forrest et al., 2004). One ostensible motivation for state monopolies has been the desire to keep lotteries free of corruption, fraud and criminal influence (NGISC, 1999; Zelenak, 2000). More subtly, however, is that the monopoly power allows the governments to maximize their revenues by producing monopoly profit. Zelenak (2000) found that 19 out 38 American lottery jurisdictions were very explicit about their intent to maximize revenues from their lottery monopolies. Forrest et al. (2000) also found evidence to support that Camelot, combined with government oversight, was maximizing their revenue with respect to the UKNL lotto game. Hyman (2010) put it this way: “Lotteries are profit-making enterprises that most states run like any business, with heavy adverting and innovation in products to generate sales”. Economies of scale may provide another rationale for a lottery monopoly. It is long established abnormal phenomenon in gambling literature that betters prefer larger jackpot with lower winning probability than smaller jackpot with higher winning probability, a phenomenon known as longshot bias (Garrett & Sobel, 1999; Golec & Tamarkin, 1998). A monopolized lottery market makes it easier to offer big jackpots. That's exactly why states have voluntarily participated in such multiple-sate games as Tri-State, LottoAmerica, Powerball and Mega Millions (Clotfelter & Cook, 1990; Cook & Clotfelter, 1993). A second feature of lottery relates to its low pay-out ratio, or the proportion of the total amount of money returned to the players to the total sales revenue. Clotfelter and Cook (1990) estimated that the pay-out ratio of lottery is approximately 50%, much lower than that offered by other gambling forms such as bingo (74%), horseracing (81%), and slot machines (89%). Based on the figures of GGY and total sales revealed by GBGC and LaFleur's 2008 World Lottery Almanac respectively, one may estimate that the pay-out ratio in 2007 was approximately (1-$98.3 billion / $224.3 billion) = 0.56. Considering the costs and taxes occurred to the gambling institutions, 0.50 would be a good estimation. The third feature of lottery is its extremely low probability of winning, as a consequence of monopolized operation, high take-out ratio, and consumers' preference for big jackpot. Take the 6/49 game as an example, it only carries a one in 14 million probability of winning grand prize. If it is 6/53 game, then the chance of buying the winning combination shrinks to approximately 1 in 23 million. Because the size of jackpot is subject to sales of current draw and rollovers from previous draws, the games have to be designed in such a way that the winning probability is extremely low and rollovers will appear at a certain pace, not too frequent and not too infrequent, thus to maximize revenue (Walker & Young, 2001).

Sports Gambling

There has been a long history of the symbiotic relationship between sports and gambling, to the extent that sometimes they are indistinguishable. Some sports also owe their very existence to the sales of their complementary good, betting, including horse racing and jai alai in the United States (Forrest & Simmons, 2003). Horse racing by itself was not a viable spectator sport in the United States. By enacting bans on bookmaking at the track, some states were able to effectively close down horse racing completely in the first quarter of 19th century (Forrest & Simmons, 2003). Then during the interwar period, the introduction of pari-mutuel betting had directly led to the revival of horse racing (Munting, 1996). Jai alai, a speedy sport involving a ball bounced off a walled space, is another non-viable spectator sport but remains popular in Florida, where the game is used as a medium for legalized pari-mutuel gambling. Forrest and Simmons (2003) suggested that the existence of a betting market for a sport can stimulate the public interest and attention to the sport, which may well translate into the profitability of particular professional sports, regardless that the sports clubs may not land direct income from betting. Although representing only 2.6% of legalized gambling market, sports betting has become the fastest growing gambling segment according to industry research group IBISWorld's report, with an annual growth rate of sports gambling is 14.7% in the past five years (AAP News, 2012).

Because of the unpredictability of competition results, sporting event has always been an attractive medium for betting. In fact, the origins of three major types of betting systems, bookmaking (fixed-odds betting), pari-mutuel betting (totalisator), and betting pool (sports lottery) were closely related to sports (Munting, 1996). Bookmaking is a gambling system in which bookmakers post odds and charge a commission for placing a bet on the outcome of sporting events, political contests, and other competitions. In this type of market, bettors are promised a fixed payoff according to the odds posted at the time of making their bets (Chung & Hwang, 2010). This profession is known from the time of ancient Rome, when betting on the outcome of gladiatorial matches or chariot races was prevalent (Encyclopædia Britannica, 2012a), and develops rapidly in the United Kingdom in 19th century for horse racing wagering (Munting, 1996). In countries where bookmaking is legalized, bookmakers may open chains of betting shops; and with the arrival of internet, many bookmakers begin to offer internet gambling outlets as well as such derivatives as betting exchanges (Koning & van Velzen, 2009). Bookmaking remains the major form of gambling in the Great Britain, whereas it is outlawed in all states but Nevada in the United States. Notable bookmakers include William Hill plc, Ladbrokes plc, and Gala Coral.

Pari-mutuel, a betting system invented in 1867 in French, differs from fixed-odds betting in that the final payout is not determined until the pool is closed. The payout from a specific outcome is inversely related to the aggregate amount wagered on that outcome relative to the aggregate amount bet across all outcomes (Chung & Hwang, 2010). That means the payoff odds are calculated by sharing the pool among all winning bets. In this system, there are no bookmakers, the bettors are essentially betting against each other. In the United Kingdoms, Australia, and New Zealand, this system is also known as the Tote after the totalisator, a machine invented to calculates and display bets already made. Pari-mutuel betting is relative insignificant in Great Britain. In the United States, pari-mutuel betting on horseracing, hound racing, and jai alai is legalized by the federal law, Professional and Amateur Sports Protection Act of 1992 (PASPA). Pari-mutuel gambling often takes place at off track facilities, where players may bet on the events without actually attending the event in person.

Betting pool, a concept introduced in 1923 by Littlewoods Pools based on soccer matches (Munting, 1996), can be regarded a variant of pari-mutuel betting influenced by lotteries. In this system, players pay a fixed price into a pool, and then make a selection on some outcome, usually related to sport. The pool is evenly divided between those who have made the correct selection. Differing from the original pari-mutuel system, there are no odds involved; each winner's payoff depends simply on the aggregate amount of betting and the number of winners. Sports lottery in most countries typically employs this adapted pari-mutuel system, including La Quiniela in Spain, and *Shengfu* Game in China. Today in England, sports lottery is more commonly referred to as football pool. The nascence of sports lottery exemplifies the symbiosis of sports and gambling, and the increasingly blurring line between lottery and sports betting.

In the United States, betting on the NCAA basketball games is very popular, which gives rise to the "March Madness" and a plethora of office pool, a derivative of betting pool (Kaplan & Garstka, 2001). The goal in these pools is to predict the winners of as many games as possible, or more sophisticatedly the point spread (Bialik, 2011). An office pool typically charges an entry fee for players to take part in the game. The entry fees contribute to a prize that is awarded to the winners of the pool in some pre-specified manner. It is estimated that the total amount of money wagered in each year's "March Madness" can rival that on the Super Bowl (Kaplan & Garstka, 2001).

However, because of its moral concerns and potential threat to the integrity of the sports, betting on sports is a very controversial issue involving tremendous contentions between the proponents and opponents. Legal sports betting exist in many countries and region, notably most European countries, Australia, Canada, and Las Vegas, typically high regulated. In the United States, bookmakers are only legal in Nevada and certain forms of sports lottery in Oregon, Delaware, and Montana in accordance with the Professional and Amateur Sports Protection Act of 1992 (Moorman, 2010). Illegal bookmaking with respect to NFL, MLB, and NBA, however, is prevalent in most parts of the country (Munting, 1996). Organizations of sports also oppose to being associated with gambling as it may lead to a disregarded status of their sports (Smith, 1992). Their concerns are not unwarranted. There are notorious cases that gambling led to match fixing and other corruptions in soccer ongoing in over 25 countries, including Chinese Supper League and Italian Soccer League (Forrest, 2012). In the United States, the National Intercollegiate Athletic Association's (NCAA) official policy prohibits any form of legal or illegal betting on their sports. In 2009, the National Football League (NFL), allying with NBA, NHL, MLB, and the NCAA sued Delaware for its legalization of offering a new type of sports lottery that allows players bet on the result of single NFL game (Moorman, 2010).

Lottery Gambling in China

Gambling is pervasive in Chinese society, and can be traced back to the first documented Xia dynasty (2000-1500 B.C.) around 4000 years ago (Lam, 2005). Higher prevalence rates of recreational and problem gambling have been reported in Chinese population among all the populations studied (Tang, Wu, & Tang, 2007; Wong & So, 2003), which can be supported by findings in behavior research. Hsee and Weber (1999) have compared Chinese and American approaches to financial risk. In a series of experiments, they found that both nationals predicted that the American would be more risk seeking, yet Chinese were significantly more risk seeking than the Americans in the domain of investment. They suggest that traditionally large Chinese family network afford people confidence that they can receive financial help if a risk does not succeed, consequently, they are less risk averse than those in an individualistic society such as the USA.

Although gambling in China is virtually a national pastime, gambling had been outlawed since the founding of the People's Republic of China in that it violates the moral system of socialism and serves a seedbed for criminal activities. According to the Amendments to Criminal Law of the People's Republic of China (VI), "Whoever, for the purpose of profit, gathers people to engage in gambling, runs a gambling house or makes gambling his profession shall be sentenced to fixed-term imprisonment of not more than three years, criminal detention or public surveillance and shall also be fined. If the circumstances are serious, he shall be sentenced to not less than three years but not more than ten years in prison, and shall be imposed upon to a fine." However, as the term "gambling" is not defined in the law, which left leeway for the governments to sneakily introduce various gambling devices under the framework of national lotteries. It seems that the Chinese governments' toleration of national lotteries and other forms of gambling activities is strikingly different. Whereas buying private lotteries was illegal, buying national lotteries is deemed as contributing to the good causes and thus is never mentioned as gambling in any officially released documents, regardless that indulgence in lottery gambling is becoming a serious social issue (Li et al., 2012; Li et al., 2011; Phillips, Liu, & Zhang, 1999).

Since the establishment of the China Welfare Lottery Committee for Raising Fund (中国福利有奖募捐委员会) in 1987, which changed to China Welfare Lottery Distribution and Management Center in 1994, and the inception of the first lottery ticket, the lottery gambling market has been rising remarkably in the last 25 years. In 1994, the second lottery distribution agency, the China Sports Lottery Administration Center (CSLAC), was officially founded. The entire market grew in total sales from 17 million *yuan* (about 2.7 million U.S. dollars) to 221.4 billion *yuan* (about 35.1 billion U.S. dollars). Specifically, Scratch card rose from a low of $138 million in 2005 to a high of $2.95 billion in 2008, an increase of more than 20 times over a period of 4 years. Lotto realized a steady increase from $5 billion in 2004 to $11.8 billion in 2008, among which dual color ball and super lotto were pillars of welfare lottery and sports lottery, respectively(Li et al., 2012). The total sales of “welfare lotteries”, the lotteries issued by the CWLDMC, reached 127.8 billion *yuan* representing 57.7% of the market, and the sales of “sports lotteries”, the lotteries issued by CSLAC, reached 93.8 billion *yuan*, representing 42.3% of the market (CSLAC, 2012; CWLDC, 2012)[1].

Almost all mainstream lottery schemes, including lotto, numbers game, instant games, and high frequency lotteries are now administered by both centers, whereas the sports lottery is only available from the CSLAC. Table 2-1 compares current CWLDC and CSLAC lottery products available in China and their market share in 2011. The CWLDC lottery, ranging from the highest to lowest in terms of total sales in 2011, includes: Duo Balls (双色球,6/33 plus 1/16 lotto), 3D (numbers game), “guaguale” (刮刮

[1] The lottery products managed by the CWLDMC are known as “welfare lottery”, and those by the CSLAC as “sports lottery” in China. However, it should be noted that the CSLAC lottery products include both actual sports lottery games which is the focus of this dissertation and the traditional non-sports lottery games. They are referred to as “sports lottery” in China because they are managed by sports administrations and the revenues are earmarked for sports related courses. To distinguish these two different meanings of sports lottery, CSLAC lottery is used in this dissertation when it comes to all types of lottery products managed by the CSLAC. Accordingly, CWLDMC lottery is used instead of “welfare lottery”.

乐, instant game), “zhongfu online” (中福在线,video lottery terminal), Happy 7 (七乐彩, 7/30 lotto), and “kailecai” (开乐彩, numbers game). The CSLAC lottery, ranging from the highest to lowest in terms of total sales in 2011, includes: “dingguagua”(顶呱刮, instant game), 5/22 high frequency game (22选5, lotto, high frequency), Super Lotto (超级大乐透, 5/35 plus 2/12 lotto), soccer betting (竞彩足球, sports betting)Pick-3 (排列三, numbers game), “shengfu”(胜负彩, sports betting), Pick-5 (排列五, numbers game), 7 star (七星彩, numbers game), “shengfu select 9” (胜负任选九场, sports betting), basketball betting (竞彩篮球, sports betting), 5/22 Lotto (22选5), goals of 4 matches (四场进球彩, sports betting), Super Lotto Luck Prize (大乐透幸运彩, lotto), and 6 matches double result (足球6场半全场胜平负, sports betting). In addition, there are many types of province-run lottery variants approved by either centers. Sports lottery, essentially a betting pool, provides a niche market for the CSLAC. In 2011, the sales of the sports lottery summed to about 19 billion *yuan*, representing 20% of CSLAC lottery market and 8.6% of the China’s lottery market (CSLAC, 2012).

Public lotteries, as a revenue source for the governments, are essentially implicit taxes (Clotfelter & Cook, 1987, 1990; DeBoer, 1986). The institution of lotteries is often based on the notion that an unhealthy but not necessarily evil course can be allowed with regulation if it can be used to raise funds for good courses (McGowan, 1994). In China, the CWLDMC lottery is to raise funds for social welfares courses, including orphanages, nursing homes, medical care, education, legal assistance, and etc.(Ministry of Finance, 2008)The allocation of the funds to each cause is not earmarked but on a need base. CSLAC lottery is to raise funds for sports development.

Specifically, 60% of the revenue is earmarked for the implementation of “National Fitness Plan”, and the rest 40% is complementary financial source for “Olympic Glorious Program” (General Administration of Sport of China, 1998). According to this interim regulation, the revenue may be used for promoting sports for all programs, building sports infrastructures for mass participation, hosting mega sporting events, and sports development in the regions under poverty line. For most types of lotteries, 50% of total sales is allocated to prizes, 35% to government revenue, and 15% to administration cost. Sports lottery is exceptional: up to 69% of total sales is allowed to allocate to prizes, and only 18% to government revenue.

Overall, the rapid growth of gambling opportunities in China is unforeseen by both gambling administrators and consumers. Chinese gambling market is facing a vigorously dynamic marketing environment with duopoly of the CWLDMC and CSLAC, and possible cannibalization of dozens of types of lotteries.

Theory of Demand and Utility of Lottery Gambling

Microeconomic theory of demand is a theory about the behavior of consumer in the market place. Its purpose is to explain the process by which consumer makes choices to maximize the utility he or she can derive from selecting the best possible combination of commodities within the budget constraint (Clarkson, 1963). Traditional demand analysis starts with an underlying utility function. Whereas utility itself involves no psychological interpretation, it is supposed to describe consumer’s preferences and rationalizes that demand behavior (Varian, 1992). The theory of demand evolves with the debates centering the fundamental assumption of rationality in human behavior, and has been gradually given much behavioral interpretation (Becker, 1962; Domencich et al., 1975; Zhang et al., 2003a; Zhang et al., 2003c). Adhering to the tradition of economic analysis, the discussion of demand for lottery gambling starts a discussion on the utility a lottery product has to offer. Why do people buy lottery tickets? And why do people simultaneously seek and avoid risks, as demonstrated in the paradoxical coexistence of gambling and insurance purchase behaviors? These have puzzled economists, sociologists, psychologists, and other scholars for decades, and lead to the germination of various modifications of the modern expected utility theory.

Expected Utility Theory and its Generalizations

The expected utility theory (EUT), originally introduced by Bernoulli in 1738 and axiomatized by Von Neumann and Morgenstern (1944), has been the underpinning of modern economic analysis of choice under risk and uncertainty . EUT holds that people take action to maximize the sum of the probability-weighted utilities of the different outcomes by comparing their expected utility values. In the context of lottery play, it suggests people's decision of buying a lottery ticket should be based on the comparison of the expected utility values of a sure thing of spending 2 dollars for buying a ticket and that of 1 in millions probability of winning the grand prize. EUT predicts that the former should always be greater than the later in that EUT takes status quo utility level into consideration and presumes a diminishing marginal utility of wealth, i.e., a continuously concave utility function. That means additional units of wealth are worth subjectively less than prior ones. And the disutility of losing one dollar is higher than the utility of gaining an extra dollar, which is known as loss-aversion in the literature. Under the intuitively plausible assumption of loss aversion, people will not be even willing to take a fair bet, not to say such unfair ones as lottery. Simply put, people should not play lotteries under the normative framework of expected utility.

The puzzle of lottery play motivated an important modification to the original EUT by Friedman and Savage (1948). Largely from the observed behavior of people's both insurancing against losses, in which they pay in order not to take risks, and purchasing lottery tickets, in which they pay to take risks, they suggested a utility curve that has two inflection points. Differing from the utility curve in EUT, the Friedman-Savage utility curve has a convex segment, reflecting increasing marginal utility and risk seeking, in the between of an otherwise concave utility curve. The lower and upper concave segments represent two qualitatively different socioeconomic levels, and the convex segment corresponds to the transition between the two levels. It can be predicted from the curve that there exists a region where the lottery ticket has greater expected utility than the certain loss of the cost of the ticket, because of the positively accelerated total utility curves. Likewise, there is a region where the expected disutility of certain loss of insurance premium is less than that of the serious loss against which he is insuring. The concave segment at higher levels of wealth limits the gains from gambling.

The advantage of Friedman-Savage utility curve lies in its ability of accommodating the empirical phenomenon of coexistence of gambling and insurance buying. It also predicts that the extremely poor and wealthy are not willing to gamble, which may or may not be true. Empirical studies indeed often show that lotteries are more prevalent in the lower-income classes than higher-income classes, but we have very limited knowledge about the extremely poor. There is another critical pitfall in this approach. As the middle segment is inherently unstable, the middle-income individuals are predicted to gamble their way into either the rich, or more likely, the poor (McCaffery, 1994; Sauer, 1998). More importantly, the utility function predicts that behavior will be sensitive to changes in initial wealth, whereas the observed gambling behavior does not appear to change radically in response to changes in their initial wealth (Quiggin, 1991). Other refinements of expected utility curve, such as Markowitz (1952), avoided this pitfall by allowing multiple dents in their utility curve. Markowitz (1952) modified the Friedman-Savage theory by assuming that utility is a function of change in wealth (i.e., gains and losses) rather than level of wealth. Another enduring problem is that the curve only fits with observed behavior without proposing efficient theoretical justification. McCaffery (1994, p. 99) criticized that “theories sketching utility functions consistent with lottery play ultimately do little more than to tell us what we already know – that people play lotteries.”

Indivisibility in Expenditure Hypothesis

Indivisibility in expenditure offers an alternative explanation of rational consumption of lottery. Whereas the kinks in the Friedman-Savage utility curve are inherent in the nature of utility, Ng (1965) was able to derive a utility curve with a convex kink caused by the existence of indivisibilities. The idea is that as consumption expenditures are not indefinitely divisible, some items must be purchased in discrete units. For example, a consumer may choose between one or two cars, but it does he little good to have, say, half a car or one and one-third cars. The introduction of indivisibility of expenditure will give rise to increasing marginal utility because the consumption of an indivisible good will lead to a reduction of consuming other goods given one’s income level. The increased marginal utility will thus induce risk seeking behavior, such as buying lottery ticket. Ng suggested that if one’s ordinary income is insufficient to pay for an indivisible good, such as university education, and would do it if he won a lottery prize, then he may buy lottery ticket even if it is less than fair.

A floppy argument exists in Ng's (1965) seminal paper deals with the influence of accessibility of financing market. Ng argued that rental market may reduce the impact of indivisibility but cannot effectively eliminate it. A further question is to what extent the mortgage market or other borrowing instruments will influence the indivisibility of consumption. McCaffery (1994) pointed out another flaw is that some apparent indivisible goods can be implicitly divisible. For example, one can buy a lesser quality car, or a smaller house, instead of a luxury sporty car, or a four bedroom house with swimming pool. Therefore, the indivisibility theory is often combined with a theory of capital market imperfection. Flemming (1969) was able to explain lottery play by assuming differences between buying and selling prices of consumer durable goods. Thus borrowing and lending in perfect capital markets removes the demand for gambles. In contrary, Bailey, Olson, and Wonnacott (1980) and Hartley and Farrell (2002) showed that when the rates of interest and time preference are equal, agents seek to gamble unless income falls in a finite set of values. When they differ, there is a range of incomes where gambles are desired. Different borrowing and lending rates can account for persistent gambling provided the rates span the rate of time preference. This offers an adequate explanation of gambling in developed countries with well-developed credit markets where a large proportion buy lottery tickets.

Based on previous research, McCaffery (1994) advanced the theory and told a more compelling story of the links between lottery play and indivisibility in consumption. McCaffery (1994) concluded that true indivisibility comes from two distinctive sources: (a) a lack of financial instruments, such as leasing or borrowing arrangements, for certain goods; and (b) consumer's rigid preference structure. For instance, for a consumer, a luxury sporty car is unsubstitutable and he cannot obtain it through financing arrangement. Then indivisibility should come to play and influence his risk seeking behavior. In such all-or-nothing situations, people are motivated to buy lottery, regardless its unfairness. As purchases that are rather easily financed by the rich become indivisible to the poor, the idea fits the empirical phenomenon that lower income groups play lower jackpot games, and upper income groups play for high jackpots. McCaffery (1994) further suggested that desire for leisure, indivisible in nature for most people, along with impediments to savings, plays a consequential role in influencing people's behavior. This point is readily integrated into the Nyman et al.'s (2008) gambling behavior model.

Leisure, a good that cannot be obtained in relatively small quantities, or through financing arrangements, is a fixed cost of work (McCaffery, 1994). The indivisibility nature of leisure, as the Ng's (1965) theory suggests, will derive a locally non-concave utility function for people. Dobbs (1988) actually showed the derivation of this kind of utility curve based on the assumption of the institutional rigidness of working hours, say, people can only choose either working or not working. This assumption is rather plausible at least in the context of the US labor market, where hiring household help, or choosing retire earlier, are not particularly vibrant (McCaffery, 1994). Dobbs' (1988) analysis concluded that people are willing to participate in small stake large prize lotteries in order to get enough money to free them from the need to work, and choose an alternative life style—the life of leisure. This labor supply perspective apparently fits the positive correlation between lottery play and the drudgery of work, with unskilled, clerical, and professional workers playing in decreasing order (Clotfelter & Cook, 1989b).

There is more than the mere utility gained from the winnings in lottery playing. Rather, it is additional utility costs that are saved by not having to work to earn the income that plays a significant role in one's ex ante gambling decisions, a basic motivation termed as "something for nothing" by Nyman et al. (2008).Their theory suggests that the utility of gambling can be evaluated in two different ways: (a) mere utility gained from the winnings, and (b) utility gained from the winnings plus the utility cost savings of not working for it, and one's working experience (i.e., labor market orientation) influences one's perception about the gambling utility. The different perceptions about the utility of gambling in turn induce different gambling decisions: to not take part in in the case of (a) or to take part in in the case of (b). Furthermore, when one indeed takes part in the gambling, then the amount and frequency of gambling are at least partially determined by the extent of difficulty to earn additional income. This labor market based theory was empirically tested based on the data from 1999-2000 Survey of Gambling in the United States. Nyman et al. (2008) used a logistic regression and ordinary least squares regression to test the hypotheses derived from their theory. They found that the odds of those who with working experiences, no matter full time, part time or not now working (but having working experience), were 2.39 to 2.72 times larger than the odds for those who never worked. In terms of amount and frequency of gambling, they found recreational gambling was more prevalent among those who engaged in service occupations, were non-white, and lived in a census block group with higher percentage of unemployment.

Weinbach and Paul's (2008) investigation of the relationship between the amount of lottery tickets purchased across the United States and the distribution of government transfer payments also lend evidence to the interplay between consumption indivisibility and limited accessibility of credit market. Using weekly lottery sales data, they demonstrated an increase in lottery activity during weeks in which transfer payments are distributed. They also found that spending increases during check week are relatively more concentrated in games with lower jackpots, indicating differences in preferences for the transfer recipient group (i.e., low income group) from the population at large. The Pick 3 and Pick 4 games are found to exhibit significant increases in sales during check week, while Pick 5 and Pick 6 games do not. They suggested that the choice of lottery games is at least partially influenced by wealth and accessibility to credit markets, a conclusion consistent to McCaffery's (1994) extended indivisibility theory.

Consumption Utility Hypotheses

Whereas the previous accounts primarily rely on the derivation of local non-concavity in the utility function without assuming any utility in gambling itself, the principal alternative explanation of gambling is that it offers direct consumption value (Bruce & Johnson, 1995; Conlisk, 1993; Forrest et al., 2002; Johnson, O'Brien, & Shin, 1999). As Samuelson (1952, p. 671) puts in this way, "What constitutes a prize is a tricky concept. When I go to a casino, I go not alone for the dollar prizes but also for the pleasures of gaming for the soft lights and the sweet music. In such cases the X's (prizes) should be complicated vectors embodying all these elements." Comparing with casino gaming, the experiential utility of lottery play is much subtle and thus controversial. A typical lotto or number game involves no more than picking some numbers or number combinations, but players can be enjoying the sense of pseudo control by having recourse to the dream books, lucky numbers, or astrology. A scratch card requires no more than scratching off the surface of the card, but players can be enjoying the thrill and excitement of discovering the numbers. A stand-alone VLT device can offer similar experience as slot machines in casino, only with lower pay-out rate. Sports lottery may require some knowledge and considerations of the teams, which may offer players a sense of "expert status", a means for supporting their teams, and sheer fun of predicting. Furthermore, all types of lottery seem to offer players an opportunity of day dreaming if life after they win the prize. If these nonmonetary activities associated with lottery gambling offers direct utility for consumers, then they certainly could be included in the calculations of expected value. Therefore, it is easy to rationalize the purchase of a lottery ticket by saying that for a dollar purchase, the customer is paying 50 cents for a fantasy (Thaler & Ziemba, 1988).

Johnson et al. (1999) documented an apparently abnormal phenomenon in the horse-racing betting market in the UK: more than 18% of bets were placed by gamblers who choose to pay 10% gambling tax on the return of a successful bet instead of on the wager when they have the freedom to choose either act. It can be shown that the former act is strictly dominated by the later act. They claimed that this phenomenon can be explained by a component of psychological utility which represents the consumption value of gambling. They modeled this consumption utility as a function of the amount of wagering. Likewise, Forrest et al. (2002) suggested that the traditional effective prize based models, such as Forrest, Gulley, and Simmons (2000) and Scoggins (1995), cannot efficiently capture the variations in demand for lottery. By contrast, Forrest et al.

(2002) proposed a key role for consumption benefit in the demand for the UK National Lottery. They argued that the impact of the maximum possible prize (i.e., jackpot) on the demand was evident for consumption utility of gambling. Using data from the U.K. National Lottery, they found that jackpot size exerted an influence over and above that of variations in effective price.

The lottery play as consumption argument is particularly tenable with regard to sports wagering and sports lottery. Indirect evidence comes from Paul and Weinbach (2010) and García, Pérez, and Rodríguez (2008). Through an analysis of the betting volumes of the National Basketball Association (NBA) and National Hockey League (NHL) obtained and aggregated across three on-line sportsbooks for the 2008-09 season, Paul and Weinbach (2010) found that betting behavior is much like fan behavior as key fan-attributes, such as the quality of teams and the availability of television coverage, were shown to have a positive and significant effect on betting volume. They resort to the consumption hypotheses to explain the pattern in their data. García et al. (2008) examined the impact of having a professional football team in the Spanish First or Second Division in a certain province on the amount of sales of football pools in Spain (La Quiniela). They estimated a demand equation using a panel data set at the provincial level for the years 1985-2005. Their results showed that having a club in the top divisions has a significant effect on sales of La Quiniela.

Despite that Johnson et al. (1999) and Forrest et al. (2002) explicitly advocated the consumption utility of gambling, their treatments were somewhat curious. Neither did they specify the nature of the consumption utility, nor the determinants of the utility. They were rather loose in reasoning the links between experiential utility and the amount of wagering or the size of jackpot. Conlisk (1993) offered a different and more elegant treatment of experiential utility of gambling, by allowing the money values and probabilities in any risky prospect have direct value beyond that included in the expression for expected utility. Conlisk contended that there is a tiny utility residing in the characteristics of gambling. He observed the following characteristics of gambling in comparison with insurance: gambling typically involves games with relatively simple rules; the probability of winning is typically straightforward or easily to conceive; although gambling involves anticipation and other time effects, but nonetheless the resolution of uncertainty is rather quick and often in entertaining ways; and gambling is typically not associated with disastrous consequences. These characteristics of gambling may stimulate a feeling of excitement or suspense for the players, which is transferable to an experiential utility. Without assuming any utility in other nonmonetary acts associated with gambling and by adding an arbitrarily small utility function of gambling to an otherwise standard expected utility function, Conlisk derived a Small Gamble Theorem and a Lottery Theorem, which specifies the boundary conditions that an individual will accept a gamble. Breuer, Hauten, and Kreuz (2009) lend additional support to Conlisk's (1993) model. They acknowledge that sports betting products apparently offer nonmonetary utility for betters because some individuals have utilized sports betting to hedge the disappointment of an unsuccessful outcome of an event they are emotionally attached to. However, they did not find the nonmonetary utility components play a direct role in betters' decision making process. They speculated an indirect effect via influencing an investor's probability assessments.

Determinants of Lottery Demand

The expected utility theory and its modifications have motivated most empirical investigations of the demand for lottery gambling. The main empirical questions are whether consumer demand for lottery games responds to true expected returns, as EUT predicts, and what factors to be included in the estimable demand functions. These works lead to two most prominent econometric models in lottery literature: effective price model (Forrest et al., 2000; Gulley & Scott, 1993) and jackpot pool model (Cook & Clotfelter, 1993; Forrest et al., 2002; Garrett & Sobel, 1999). Besides product attributes variables, namely effective price and jackpot size, consumer characteristics variables such as income, gender, age, education, religion, and ethnicity (Felsher et al., 2003; Herring & Bledsoe, 1994; Walker et al., 2006), and used marketing variables such as venue accessibility (Hing & Haw, 2009), cross border competition and product substitution(Forrest et al., 2004; Garrett & Marsh, 2002), and social responsibility marketing (Li et al., 2011) were also included to model the demand for lottery products. Finally, drawing upon the consumption utility experience hypothesis, a third product attributes variable that may be unique to sports lottery is the attractiveness of the matches included in the parlay.

Product Attributes and Demand

Effective price

There are two different prices in the market for lottery games. The nominal price of a lottery ticket, usually fixed at a very small value, say, $1 in US, or two *yuan* in China, is what the players actually pay for a chance of winning a prize. The actual price of a ticket, however, is different. It is known as effective price in literature, and can be defined as “the cost of buying a probability distribution of prizes that has expected value of one dollar” (Clotfelter & Cook, 1987, p. 534). Effective price of a unit price lottery ticket can be measured by the difference between its face value and the expected value of the prize, which tends to converges to the takeout rate with sufficiently long periods of time (Gulley & Scott, 1993). An alternative specification of effective price is the inverse of the expected value (Garrett & Sobel, 2004). Some earlier empirical analyses of lottery sales included the takeout rate as a proxy explanatory variable for effective price, but found no significant relationship between effective price and sales (Mikesell, 1987; Vasche, 1985; Vrooman, 1976). It is likely due to lack of variability in the takeout rate. For example, in the United States, states typically do not vary this rate over time nor does it vary much across states. When the variation in the takeout rate is rather limited, researchers can hardly detect a significant relationship. DeBoer (1986), however, is an exception. Using panel data for seven state lotteries from 1974 to 1983 and controlling for per capita disposable income, the number of years the lottery has operated, and the percentage of the population residing in urban areas, the researcher found a significant relationship between the takeout rate and sales. The price elasticity of demand was estimated at -1.19, meaning a 1 percent cut in the takeout rate increased sales by nearly 1.2 percent. DeBoer (1986) further showed that if the payout rate is 50 percent and marginal administrative costs 3 cents per dollar of additional sales combined with an average sates commission of 5 percent, net revenues for the state are maximized if the elasticity is -1.19.

Although the effective price has to average at the takeout rate over the whole period of the lottery business, variation from this is permitted in any given draw. Indeed, the rules of roll-over and pari-mutuel betting along with a carefully designed prize structure induce substantial changes in price between draws (Gulley & Scott, 1993). We observe that the draw-to-draw sales of lottery tickets sometimes fluctuated dramatically. This can hardly be explained by nonprice variables, such as income or demographic characteristics, which do not vary much in short-run. Gulley and Scott (1993) suggested that the expected value of holding a ticket is a function of the prize structure, the amount of the previous jackpots rolled over into the current jackpot, and the number of tickets purchased in the current drawing, and formally defined it as: EV = $|p|$*|JACKPOT|*|SHARE| + EV_s, where EV is the expected value of a $1 lotto ticket, p is the probability of winning the jackpot, JACKPOT is the value of jackpot, and SHARE is the expected portion of the jackpot a winner will keep, and EV_s is the expected value of smaller prizes. EV_s is usually fixed in the UK Lottery and the United States state lotteries. However, it can be modeled differently in cases where lotteries have a different prize structure. Cook and Clotfelter (1993) and Gulley and Scott (1993) showed that the probability of winning a grand prize can be appropriately approximated by the Poisson distribution. Subsequently, $P = 1 – EV = 1 – ((1/Q)(R+(1-t)Q)(1-e^{-Qp})+EV_s$, where P stands for the effective price of a $1 lotto ticket, Q is the number of tickets sold in the draw, t is the take out rate, and p is the probability of any ticket winning the jackpot. This has been a classic specification in modeling price elasticity of lottery demand, and adopted by several subsequent researchers, notably Scott and Gulley (1995), and Garrett and Sobel (2004) for the US state lotteries, Walker (1998), Farrell and Walker (1999), Farrell, Morgenroth, and Walker (1999), and Forrest et al. (2000) for the UK Lottery.

However, there is one critical estimation problem in empirical investigation. The effective price variable is necessarily endogenous as it is influenced by sales. As sales increase, the number combinations covered by players will increase, making it less likely that the grand prize will remain unwon. Hence, expected value to ticket holders improves and effective price falls when sales increase. But the sales cannot be exactly known *ex ante*. Assuming that players form their rational expectations of the effective price using all the available information, researchers may remedy this endogeneity problem by running a two-stage estimation procedure. In the first stage, the effective price is estimated using information that was likely available to players at the time of purchase, such as sales in previous draws, trends in sales, prior rollover amounts, or public sales forecasting. In the second stage, the predicted effective price is then included as a regressor in the demand equation. Gulley and Scott (1993) obtained expected effective price by regressing actual effective price on the amount of roll over from previous drawing, the predicted jackpot and a time trend. Using data related to various periods over 1984 to 1991 and the number of drawings observed for individual game varied between 120 and 569, they found that the price elasticities vary across different games. In the cases of Kentucky Lotto and Ohio Super Lotto the measured elasticity was -1.15 and -1.20 respectively, which was consistent with profit maximization; however, in the cases of MassMillions and Megabucks, the measured elasticity was -1.92 and -0.19 respectively, which was significantly deviated from -1.19. In a similar token, Forrest et al. (2000) used the size of rollover and its square as instrumental variables in their two stage procedure. They estimated the steady-state long-run elasticity of demand for the UK National Lottery was -1.03, which is not significantly different from revenue-maximization.

Modeling demand in terms of the effective price describes the effect of the implicit cost (i.e., the effective price) on the amount of tickets players choose to purchase. It is consistent with the logic of the expected utility theory and rests on the assumption that players form rational expectation of effective price and use this information in the process of purchase decision. The importance of this model lies with its regulatory implications – to maximize sales implies an approximate price elasticity of -1. However, the effective price model relates sales only to the total prize payouts, but not to the structure of prizes, which effectively limits the applications of this model in real world lottery operations. Forrest et al. (2002) cited an anecdote in the history of the UKNL that evidently violates the prediction of the effective model. In September 1998, an introduction of extra prize money to the second-tier prize pool (i.e., a reduction in effective price) surprisingly reduced the sales of the lottery.

Jackpot size

A number of studies have explored the effect of characteristics of prize structure on the demand, especially the size of jackpot. Motivated by Conlisk's (1993) tiny utility in gambling and the idea of "buying a lottery ticket is buying a dream" (Clotfelter & Cook, 1989b), Forrest et al. (2002) raised the hypotheses that the variation in sales of lottery ticket may be driven primarily not by the effective price but by the prospective size of jackpot pool. Similar ideas actually could be found in Cook and Clotfelter (1993) and Garrett and Sobel (1999).They argued that lottery players may be simply motivated by the enjoyment of the dream of spending the largest prize that could be won from holding the ticket, rather than the expectation of winning the prize. The jackpot pool was defined as the largest amount that anyone could win as a single winner. Forrest et al.'s (2002) jack pool model essentially is not different with Cook and Clotfelter's (1993) time series model, in which they include jackpot as a major predictor for lotto demand. Based on a dataset of 169 consecutive lotto drawings in Massachusetts, Cook and Clotfelter's (1993) estimated the jackpot elasticity of demand was 0.347, implying that a $1000 increase in the expected jackpot increased sales by $347 dollars.

For the same reason as the effective price that the total sales cannot be determined until the close the drawing, the jackpot pool is necessarily endogenous. The players, however, may be able to form an expectation of the jackpot size using the information available at the time of purchase. This assumption might be more plausible than that in the effective price model according to the cognitive decision theory. Players likely attend to only a few key discrete values such as the amount of the large prize rather than statistics such as expected value in their decision to buy lottery ticket (Shapira & Venezia, 1992). Both Cook and Clotfelter (1993) and Forrest et al. (2002) used the amount of rollover from previous drawings as an instrument for the jackpot size in their two stage least square procedure. The jackpot pool model has the same structure as the effective price model. Based on 137 drawings of UKNL data, Forrest et al.'s (2002) estimated the elasticity of demand with respect to expected jackpot were 0.162 and 0.195 for the Wednesday and Saturday draws, respectively. In comparison with effective price model, they found that the jack pool model explains a greater proportion of variance (88% and 90% vs. 83% and 72% for Wednesday and Saturday draws, respectively).

Modeling demand in terms of the jackpot describes the halo effect of the grand prize on the amount of tickets players choose to purchase. It is consistent with the lottery play as consumption experience account and rests on the assumption that larger jackpot represents greater utility for players. It is also consistent with an information account proposed by Shugan and Mitra (2009) that under adverse environments favorable outcomes convey more information than unfavorable outcomes. In this case, the maximum data (jackpot) may contain more information than the average data (effective price). The importance of this model lies with its implications for lottery design. For example, by increasing the difficulty of the game, say, switching from 6/49 to 6/53 while preserving the total prize money, can effectively increase the possibility of rollover, hence a greater jackpot. If the jackpot pool model holds, the increased jackpot should bolster additional sales. Cook and Clotfelter (1993) showed that the lure of a larger jackpot brought new money into the lottery. The increased sales did not come at the cost of sales of other lottery games. However, the jackpot pool model, relating sales only to the grand prize payouts, cannot effectively explain the lottery demand in a situation where prize cap is enforced. For example, the Chinese lottery administrations voluntarily set a 5 million *yuan* prize cap for a single stake. Whereas the jackpot pool can be hundreds of million *yuan*, the expected jackpot for a 2 *yuan* single stake ticket will be at most 5 million *yuan*. However, players can increase their chances of winning more than 5 million *yuan* by buying more tickets. The traditional jackpot pool model fails to account the prize cap. Furthermore, this model fails to predict the optimal difficulty level of the game. The jackpot pool model suggests that more difficult game is always preferable than those easier game.

Estimation problems

Forrest et al. (2002) used the Cox statistic for testing the effective price model and jackpot pool model as these two models were non-nested. Results revealed that neither model contains a correct set of regressors. Forrest et al. (2002) suggested that both effective price and jackpot pool were important determinants of demand of lottery, and should be included in the demand model. But a test of this model was empirically not feasible in their study as rollover was used as instrumental variable for both effective price and jackpot pool. This problem was evident in Cook and Clotfelter (1993), who did include both the expected value and jackpot size in their model. Their findings were peculiar: sales were positively related to the jackpot, but *negatively* related to expected value. They suggested that the results were due to high multicollinearity. García and Rodríguez (2007), in their estimation of the demand for the Spanish football pools using data corresponding to the fixtures (football matches) from the 1972-73 to the 2002-03 seasons, also included both effective price and jackpot in their equation. Although they claimed that this approach was appropriate following Kelejian (1971). Again, their results were peculiar: sales of Spanish football pool was positively related to the jackpot, but also *positively* related to the effective price. Beenstock and Haitovsky's (2001) investigation of lottomania phenomenon in Israel was an exception. The Israel lottery administration, *Mifal Hapayis*, has a minimum jackpot policy for its lotto game. The lower bound for the first prize, to be announced a week in advance of the following drawing, is based on the lotto managers' assessment of ticket sales. The first prize will be greater than the announcement under the circumstances that sales exceed expectation; otherwise, *Mifal Hapyis* absorbed the loss and pay the promised jackpot. Because the *Mifal Hapyis* does not use a simple projection rule based on rollover data alone, the promised jackpot was shown sufficiently independent of rollover data. This enables the separate identification of the effective price and jackpot size induced by rollover. The loglinear model relating sales to promised jackpot and price based on 594 lotto drawings in Israel from 1985 to 1996 revealed a jackpot elasticity of 0.415 and price elasticity of -0.663.

Prize structure

Another line of research examined the relationship between the skewness of the prize distribution and lottery demand. It has been an established abnormality in horse racing, known as long-shot bias, that betters prefer low-probability, high-variance bets (long shots) than high-probability, low-variance bets (favorites) (Thaler & Ziemba, 1988). Golec and Tamarkin's (1998) explanation was succinct: "bettors love skewness, not risk, at the horse track". The enjoyment of the high skewness offered long shots was the key motivation for horse track betters. Golec and Tamarkin used the third moment about the mean of return to model this skewness. Garrett and Sobel's (1999) examination of the skewness of the prize distribution on lottery demand was simply an application of Golec and Tamarkin (1998). Garrett and Sobel estimated the model $\mu(X_g) = \mu(X_G)\ P_G/P_g = \beta_0+\beta_1 X_g+\beta_2 X_g^2 +\beta_3 X_g^3$ based on data of 216 on-line lottery games offered in the U.S. during 1995. This equation implies that $\mu(X_g)$, the expected utility of winning first prize of any lottery game g equals to $\mu(X_G)$, the expected utility of winning first prize of the lottery game G which offers highest jackpot among all games, multiply by the ratio of the probability of winning X_G (P_G) and the probability of winning X_g (P_g). Similar to the jackpot pool model, Golec and Tamarkin's model explicitly assumed that players were motivated by the top prize jackpots. The coefficient β_1 captures bettors' references over the mean of returns, whereas risk aversion is determined by the size of β_2: $\beta_2>0$ suggests risk loving, $\beta_2<0$ suggests risk aversion, and $\beta_2=0$ suggests risk neutrality. A player's preference for skewness is measured by β_3. A positive β_3 would imply a favorable preference for skewness, whereas a negative β_3 would reflect a dislike for skewness. The empirical results supported their original prediction: $\beta_1>0$, $\beta_3>0$, and $\beta_2<0$, suggesting that the mean return along with the skewness of prize structure have an impact on demand.

A complementary line of research examined the relationship between other aspects of prize structure and lottery demand. Shapira and Venezia (1992) investigated the roles of size and frequency of prizes play in determining the demand of lottery. Their first study was conducted based on the Israeli Lotto system for a period of 60 months from 1986 to 1988. The weekly sales data were regressed on two explanatory variables: the promised minimal first prize, a proxy variable for the amount of the first prize, and the number of winning tickets from the previous winning tickets from the previous week, a proxy variable for the probability of winning. The regression results revealed that both variables were significant determinants of lottery demand. Their second study was run in an experimental type setting. Subjects rank ordered their preferences among various hypothetical lotteries that differ in price, probability of winning, and frequency of winning but with a fixed pay-out rate of 50%. The results of the experiments indicated that larger jackpots were preferred to larger secondary prizes, and more frequent secondary prizes are preferred to lower ticket prices. Overall, the size of the first prize as well as the number of small prizes had the effect on the demand for lotteries in Israel.

Game attractiveness

Unlike other lottery games, attractiveness of the sporting events is likely another product feature influencing demand for sports lottery. Game attractiveness has been established as the most important determinant in market demand for spectator sports in sports management literature (Zhang, Pease, Hui, & Michaud, 1995; Zhang et al., 2003a; Zhang et al., 2001). In accordance with the lottery play as consumption argument, the attractiveness of the sporting events seems also play an important role in influencing players' decision to buy a ticket. Through an analysis of the betting volumes of the National Basketball Association (NBA) and National Hockey League (NHL) obtained and aggregated across three on-line sportsbooks for the 2008-09 season, Paul and Weinbach (2010) showed that betting behavior is much like fan behavior as key fan-attributes, such as the quality of teams and the availability of television coverage, were shown to have a positive and significant effect on betting volume. They resort to the consumption hypotheses to explain the pattern in their data. García et al. (2008) examined the impact of having a professional football team in the Spanish First or Second Division in a certain province on the amount of sales of football pools in Spain (La Quiniela). They estimated a demand equation using a panel data set at the provincial level for the years 1985-2005. Their results showed that haying a club in the top divisions has a significant effect on sales of La Quiniela.

Consumer Characteristics and Demand

Income

There is evidence that the demand for lottery is likely to depend on the socio-demographic structure of the population. Previous studies have sought to explore the impact of socio-demographic factors on lottery demand, particularly income. The estimated effects of income on lottery demand in previous studies have been mixed, but the collective evidence suggests that lottery expenditures do not systematically depend on income, and the lottery tax generally is regressive but with substantial differences in the degree of regressivity across different lottery games. The regressivity of tax means that the percentage of total tax burden consistently exceeds the corresponding percentage of total income all the way through the income scale. In literature, there are two ways to demonstrates this regressivity: a computation of the Suits Index of tax incidence (Suits, 1977b), or an estimation of income elasticity through regression analysis.

A direct measure of tax regressivity developed by Suits (1977b) was frequently adopted to evaluate the regressivity of tax incidence of lotteries. Calculation of this index is analogous to calculating the Gini coefficient. It is defined as S=1-(L/K) where L is the area under a Lorenz type curve and K is the area under the diagonal. The value of Suits index of regressivity ranged from -1 of the extremely regressivity to +1 of the extremely progressivity with the former value reflecting extreme regressivity and the latter value extreme progressivity. A value of 0 indicates a proportional tax. Suits (1977a) found that state lotteries rated -0.31 on the regressivity index and illegal numbers games -0.44, more regressive than horses at the track (-0.17) and off-track betting parlors (-0.07). Adopting Suits' measure, Clotfelter (1979) estimated the regressivity index value of the daily and weekly numbers games in Maryland at -0.41 and -0.24 respectively, showing that the daily numbers game was more regressive than the weekly game. Also, Clotfelter and Cook (1987) found both Maryland's three-digit (-0.42) and four-digit numbers games (-0.48) were more regressive than the state's lotto game (-0.36). More recent application of this measure includes Price and Novak (1999), who found the Suits index values of lottery games in Texas ranged from -0.18 to -0.48, and Combs, Jaebeom, and Spry (2008), who advocated a bootstrap method to make statistical inference on the Suits index and compared eight games in Minnesota with Suits index values ranging from -0.13 to -0.34.

Income elasticity measures the responsiveness of the demand to a one percent change in one's income. It can be readily obtained by regressing the natural logarithm transformation of sales to the natural logarithm transformation of income, controlling other variables. A coefficient of log income below one demonstrates regressivity. If the coefficient is one, the tax is proportional, and if greater than one, it is progressive. Based on a survey of the Pennsylvanian Lottery winners, Spiro (1974) found an income elasticity of 0.22. However, the conclusion was merely suggestive as the survey itself was marred by a relatively small sample size (271) and an unusually low rate of usable responses (22%). Likewise, Brinner and Clotfelter (1975) showed an inverse relationship between family hold income and the percentage of their incomes on public lotteries. More recent studies that demonstrate regressivity include Clotfelter and Cook (1987), Price and Novak (1999), Ghent & Grant (2010) for various states in the US, Farrell and Walker (1999) for the U.K. National Lottery, and García et al. (2008) for the Spanish Football Pool. Despite that these studies differ in empirical approach and in the use of aggregate or survey data, this regressive pattern persists.

However, Mikesell (1989) questioned the conventional wisdom about the regressive character of the lottery. He showed that estimated income elasticities for instant games and on-line games in Illinois are not statistically different from one. Scott and Garen (1994) found income have a positive, but declining effect on the probability that an individual plays the lottery. Interestingly, once they control for the probability that an individual plays the lottery, income has no significant effect on lottery expenditures. Rubenstein and Scafidi (2002) found similar results using individual-level data from Georgia. Ghent and Grant (2010) examined the distributional impact of three types of lottery games operated by the South Carolina Education Lottery (SCEL). They found substantial differences in the degree of regressivity across three types of games. By estimating the determinants of lottery sales using variables that capture the distribution of income rather than simply its level, they concluded that lotteries may not be as regressive as suggested by the earlier literature. Miyazaki, Hansen, and Sprott (1998) lend additional evidence that lottery regressivity levels were not constant over time and may become less regressive as they progress through their individual life cycles and as new marketing efforts-such as anonymous methods of play--become more prevalent. Similarly, Garrett and Coughlin (2009), estimated annual income elasticities of demand for lottery tickets using county-level panel data for three states and find that the income elasticity of demand for lottery tickets has changed over time. This is due to changes in a state's lottery game portfolio and the growth in consumer income more so than competition from alternative gambling opportunities. Oster (2004) found evidence based a dataset on Powerball lotto sales that large-stakes game is significantly less regressive at higher jackpot sizes. Out-of-sample extrapolation of this result suggested the lottery becomes progressive at a jackpot around $806 million. At country level, Kaizeler and Faustino (2008b) found an inverted U relationship between lottery sales and per-capita GDP. Using lottery sales data in 2004 for 80 countries, lottery sales increase together with increases in GDP up to a point where a country has reached a level at which the GDP is high enough and lottery sales become an inferior good and as a result, start to decrease.

Age

Although the ability to maximize expected value improved with age, there was an inverted U-shaped developmental pattern for risk-seeking (Burnett, Bault, Coricelli, & Blakemore, 2010), suggesting there may be an inverted-U relationship between age and lottery expenditures. Clotfelter and Cook (1989a) found individuals aged 25–64 are more likely to play the lottery than those who are younger (18-24) and who are older (65 and above). Also, Scott and Garen (1994) detected an inverted-U relationship between age and lottery participation in the United Stage. However, this trend was no longer detected in the 1999-2000 survey (Welte et al., 2002). Lottery participation by four age groups (18–30, 31–40, 41–50, and 51–60) did not differ much from each other (68, 70, 69, and 66% respectively), with mean amounts of individual lottery expenditure per year varied at $234, $382, $321, and $336, respectively. Participation by the 61+ age group was the lowest at 55%, but their mean amount of individual lottery involvement was the highest at $424 (Welte et al., 2002). Jackson (1994) in his study of the Massachusetts state lottery lend some insights for this transition. He found in 1983 the proportion of the population age 65 or older was inversely related to per capita lottery sales. By 1990, this relationship had been reversed. The 65 or older age group had become a significant factor in raising per capita sales during the period from 1983 to 1990. Price and Novak (1999) found that median age is inversely related to sales of Lotto and Pick 3 tickets, but positively related to the sales of instant games. Ghent and Grant (2010) in their study of North Carolina Education Lottery found the proportion of the county population age 65 or older was significantly and positively related to the sales of instant lottery tickets, but had no effect on the sales of fixed-number or Lotto games. Additionally, a survey of adult Chinese lottery gambling behavior revealed a strict decreasing relationship between 5 age groups (21 to 30, 31 to 40, 41 to 50, 51 to 60, and 61+) and lottery gambling, with the 21 to 30 age group representing highest 29.5% and 61+ age group representing lowest 5.6% market shares (Li et al., 2012). A trend was consistent with that of general gambling behavior as reported by Mok and Hraba (1991). As adolescents were not allowed to purchase lottery tickets in China, this may have prevented the observation of an inverted U-relationship between age and lottery expenditures.

Education

The level of education is an important determinant of one's earning function. It has been confirmed by hundreds of studies that better-educated individuals earn higher wages than their less-educated counterparts (Card, 1999). With understanding that lottery participation is generally negatively associated with income level, it is also likely to be true with education. Additionally, there is some evidence to support the notion that certain courses received from formal education may improve one's rationality, thus better-educated individuals may fall less to those cognitive misconceptions frequently identified in gambling. For example, Schoemaker (1979) found a statistics course might help students make more consistent and less risky gambling decisions. Fong, Krantz, and Nisbett (1986) found that statistical training sometimes transfers to real-world decision making. Nisbett, Fong, Lehman, and Cheng (1987) conducted several tests on the effects of different kinds of training on logical skills. They found that logical skills (as measured by their tests) did improve as a result of two years of graduate courses in law, medicine, or psychology. Although never demonstrated empirically in the lottery gambling literature, it is rather plausible that education has an additional impact on lottery expenditure beyond its effect through income. Indeed, researchers in lottery gambling typically found a decreasing relationship with general education. Brown, Kaldenberg, and Browne (1992) disaggregated the socio-economic effects of education, occupational status and income to conclude that it was the poorer households who spent the greatest percentage of their household budgets on the state lottery. Education, the single best predictor of lottery play, was a significant and negative correlate. Scott and Garen (1994) and Rubenstein and Scafidi (2002) found an inverse relationship between education and the probability of lottery play. In their analysis of the Tennessee Education Lottery, Giacopassi, Nichols, and Stitt (2006) report a negative relationship between the proportion of a county's residents with a college degree and that county's lottery sales. Ghent and Grant (2007) confirmed the role of education in determining lottery sales by finding that total sales depend positively on the proportion of a county's residents without a high school diploma in South Carolina. Price and Novak (2000) reported that the percentage of a county's residents with a bachelor's degree was positively associated with Lotto sales, but negatively associated with scratch-off instant games. Similarly,Ghent and Grant (2010) found the percentage of a county's residents with a bachelor's degree and percentage of a county's residents without a high school diploma were positively associated with Lotto sales, but negatively associated with fixed-number and instant games. However, all the coefficients were not significant.

Gender

Men are found more likely to be less risk-averse, in addition to being more susceptible to over-confidence (Barber & Odean, 2001), which may intensify gambling behavior in men. According to a national random-digit-dial telephone survey of U.S. adults conducted in 1999–2000, men gambled in lottery slightly more than did women (68 vs. 64%), but the amount gambled was significantly higher for men ($362) than for women ($295) (Welte et al., 2002). The pattern of gambling participation has changed significantly comparing with the previous two national surveys conducted in 1975 (Kallick-Kaufmann, 1979) and 1998 (Gerstein et al., 1999). The pattern of participation also differs in different culture and society, being influenced by the availability and social acceptance of different types of gambling for both males and females. For example, women in Australia were reported having a higher preference for bingo, lotto, and lotteries than men (Hing & Breen, 2001). Whereas women were reported gambling in lottery more than men by a small margin in Thailand(52.6% vs. 47.4%) (Ariyabuddhiphongs, 2006), men had a much higher share in China's lottery market (77.3%) (Li et al., 2012).

Religion

Religiosity is an important construct in understanding individual's gambling behavior. Roberts, Arth, and Bush (1959) ascertain that gambling, as games of chance, is associated with religious beliefs and is exercised in relationships with the supernatural. On the other hand, religion is a proxy for moral opposition. The perception of gambling as an immoral activity based on the greediness and overindulgence in humanity is the reason some religions forbid or strongly oppose it (Cotton, 1996). Diaz (2000) found that the religion and the religious practices of Las Vegas residents did affect their gambling patterns, including the frequency of gambling and amount of money spend on gambling. Also, Lam (2006) found that gambling participation across four types of games, namely casino games, track betting, lottery, and bingo, was significantly associated with one's frequency of religious participation. Scott and Garen (1994) found Neo-fundamentalist Protestants are less likely, and Roman Catholics are more likely to participate in lottery gambling. Other religious affiliations had no discernible effect on whether or not an individual buy lottery tickets. Ghent and Grant (2007) found that religious affiliation has a significant effect on the vote to establish a lottery, but has not on lottery sales once a lottery has been established. At country level, Kaizeler and Faustino (2008a) found a positive relation between Christians and lottery sales. The increase of 1% in a country's Christian followers leads to an increase in per-capita lottery sales of $40.20. But this variable was not significant for the model.

Ethnicity

Another feature studied by various researchers is the link between race, ethnicity and gambling behavior. Risk perceptions and risk taking behaviors were found to be culture sensitive (Weber & Hsee, 1998; Weber, Hsee, & Sokolowska, 1998). People from different cultural background thus may have different gambling propensity. In the United States, several studies revealed that the black play the lottery more than whites do (Clotfelter and Cook, 1987; Borg and Mason, 1988; Rubenstein and Scafidi, 2002; Ghent and Grant, 2007). Gerstein et al. (1999) in their national in their 1998 national survey found that the black respondents spend nearly twice as much on lottery tickets as do white and Hispanic respondents. The average reported expenditure among blacks is $200 per year, $476 among those who played the lottery last year. Black men have the highest average expenditures. Giacopassi, Nichols, and Stitt (2006) find no effect of race on total lottery sales in Tennessee, but when sales are sorted by game type, they find that African Americans play significantly more online games than their white counterparts.

Additionally, Clotfelter and Cook (1989), and Price and Novak (1999) defend that Hispanics are more likely to gamble than other ethnicities. Kaizeler and Faustino (2008a) in their cross-country study did find African countries spend, on average, 51 USD more per capita than other countries. But they did not find a significant positive relationship between the Latin countries and lottery sales. On average, Latin countries spend 6.68 USD more per capita than other countries. Several studies have also made reference to the prevalence of lottery gambling among Chinese residents in mainland China (Li et al., 2012), Canada (Chinese Family Services of Greater Montreal, 1997), Hong Kong (Chen et al, 1993) and Taiwan (Hwu et al, 1989; Yeh et al, 1995). Higher prevalence rates of recreational and problem gambling have been reported in Chinese population among all the populations studied.

Marketing Variables and Demand

Border competition

Researchers have shown that a lottery product is likely to subject to the competition from the bordering state, other gambling opportunities, and other types of lottery. Cross-border shopping of consumer products exists in many places in Europe and North America due to differences in tax rates, prices, and geographical convenience (minimal transportation costs) across states or countries (Asplund, Friberg, & Wilander, 2007; Ferris, 2000). In the United States, there is substantial evidence showing that this cross-border shopping for lottery products indeed exists. Alm, McKee, and Skidmore (1993) and Caudill, Ford, Mixon, and Peng (1995) defended that the inauguration of a lottery in neighboring states, thus a concern for the potential lottery revenue loss to neighboring states, was a primary motivation for some American states to adopt a lottery scheme. Mikesell and Zorn (1987) showed that the absence of competing lotteries in neighboring states has a significant positive effect on per capita sales. Besides the apparent advantages of neighboring with non-lottery states, bordering with lottery states is inevitable a disadvantage. Each state offers lottery games that are unique to the state, thus lotteries differ considerably across states in terms of prize payouts, odds of winning, jackpot size, or effective price. Players living in border area actually take advantage of these product differentials and engage in cross border lottery patronage. Garrett and Marsh (2002) was the pioneer in detecting this spatial correlation pattern in lottery demand by examining lottery revenues in Kansas, which is surrounded by Nebraska, Oklahoma, Colorado, and Missouri. They provided evidence that cross-border lottery shopping had a significant net negative impact on state lottery revenues in Kansas, and the amount of cross-border shopping depends on the size of the retail sector in the relevant border county. Tosun and Skidmore (2004) confirmed this negative impact of border competition in their study of the demand for West Virginia lottery. Data related to lottery sales for all 55 counties in West Virginia over the period 1987-2000. They focused on the effects of the introduction of new neighboring state lottery games on West Virginia lottery revenue generating capabilities. Their findings indicate that border state competition was an important determinant of lottery sales. Furthermore, Brown and Rork (2005) showed that the take out rate of lottery is subject to interstate competition. Using data from 1967 to 2000, they provided evidence that the payout rate of state lotteries responds positively to the payout rates of neighboring states. Moreover, their estimates of competition become even stronger upon controlling for the issue of self-selection that occurs with adopting a lottery.

Product substitution

Virtually all lottery administrations offer a variety of games to suit the tastes of players in an attempt to maximize revenue to the government. It is a natural concern that different games may cannibalize each other. A major competitive threat of introducing a new game consists of two factors that influence demand: the newly introduced game substitutes or complements the existing games. Economic theory predicts that complementary goods will facilitate sales for each other, whereas close substitutes can potentially intensify internal rivalry and reduce profitability. Clotfelter and Cook (1989) believed that the standard lottery games were not substitutes for one another. The sales of scratch-card tickets was not affected by the introduction of lotto games. Purfield and Waldron (1999) tested the substitutability (complementarity) between the pari-mutuel lotto game and the fixed-odd betting on the Lotto draw in the Republic of Ireland, and found the two games tend to be complementary to each other. Forrest et al. (2004), however, found evidence of some substitution among the variety of games offered by the United Kingdom National Lottery: the lotto and scratch-card games were partially substitutable, whereas Thunderball appeared independent of the other two games; the Wednesday and Saturday drawings of the lotto game were substitutes, but the introduction of a new game, Big Draw 2000, contributed to net sales. Grote and Matheson (2006) considered the potential substitution relationship between two lotto games offered simultaneously in Colorado. One is the Powerball, a larger multi-state lotto game run in coordination with other states, and the other Colorado Lotto, a smaller individual state run lottery. They concluded that while the two products do tend to be complements to one another, overall the individually run state lottery games experience a reduction in sales from the presence of the multi-state game.

Several researchers also explored the demand impacts of competition between state lotteries and other forms of gambling opportunities, such as pari-mutuel racing and casino gambling. Gulley and Scott (1989) explored the substitute relationship between lotteries and thoroughbred horseracing based on relevant data covered a time period of 1976 to 1980. They reported an estimated coefficient of -0.18 for real lottery revenue per capita, which means that an additional dollar bet per capita on the state lottery leads to a decline of approximately 18 cents in a typical track's average handle per patron. A similar substitution effect was found in California from 1986 to 1989 by Vasche (1990), who estimated a coefficient of -0.26. Empirical research on the issue of commercial casino and lottery competition is explored by Elliott and Navin (2002). They found that during the period 1989-1995, expenditures on riverboat gambling had a negative impact on state lottery demand. They estimated that a dollar increase in riverboat gambling was met by an 83-cent decline in net lottery revenue. However, as low-revenue lottery states are more likely to legalize casinos, this can partly explain the negative relationship between casinos and lotteries. By correcting potential sample-selection bias in the process of state's legalization of commercial casinos, Fink (2003) extended Elliott and Navin's (2002) study and reported a coefficient of -0.56. Walker and Jackson (2008) analyzed the competitive pattern of the four major gambling industries in the United States, including casinos, greyhound racing, horse racing, and lotteries, during a period of 1985-2000. Their results indicated that casinos and lotteries cannibalize each other, whereas both dog racing and horse racing help lottery sales. In contrast, in the

UK setting, Forrest, Gulley, and Simmons (2010) found some evidence that bettors do substitute away from horse race, soccer and numbers betting when the effective price of lottery tickets is unusually low induced by a rollover or other special draw. Borg, Mason, and Shapiro (1991) examined a series of lottery expenditure models at the household level and had different insights about the interrelationship between lottery and other gambling activities. Their results showed that lottery expenditures did not come at the expense of other household or gambling expenditures, but at the expense of charitable contributions. Kearney (2005) confirmed that spending on lottery tickets is financed completely by a reduction in non-gambling expenditures, which implies that other forms of gambling are not harmed by a lottery. Paton, Siegel, and Williams (2003) reported that the substitution effect between the UK National Lottery and sports betting was not significant. They contended that the introduction of the National Lottery may actually have led to a climate in which gambling as a whole became more socially acceptable.

Over all, the literature suggests that the relationships among different lotteries or gambling industries are complicated. An industry (lottery) can either harms another industry (lottery) or does not affect it, or different gambling industries (lotteries) help each other.

Venue accessibility

Venue distribution plays a fundamental role in marketing gambling products. Several studies have examined the relationship between gambling venue accessibility and the demand for gambling products. Shiller (2000) contended that an individual's geographical whereabouts may induce gambling, when considering the greater availability of gambling facilities in urban areas that provides more opportunities to buy tickets. The availability of gambling opportunities, particularly with regard to facility density and venue proximity to home, work or other convenient locations, was found to be associated with demand for gambling products and the prevalence of program gamblers (Hing & Haw, 2009; Welte, Wieczorek, Barnes, Tidwell, & Hoffman, 2004). Sleight, Smith, and Walker (2002) reported a case about how Camelot managed to optimize its outlets to increase venue accessibility for its customers. The effects of venue accessibility on lottery demand, however, has not yet empirically documented in the literature.

Social responsibility marketing

Governments establish lotteries, aiming at channeling people's innate gambling impulse to more constructive courses. Nevertheless, lottery is a product of potential addictiveness. It can induce some social problems and lead to unnecessary social costs. For this reason, lottery issuance and administration institutions need to limit the pervasive effects of adverse consequences associated with lottery gambling. The impact of social responsibility on the lottery demand has limited to Li et al. (2011), who investigated the interrelationship in the context of China's sports lottery market. They found that government social responsibilities primarily lie in two dimensions: regulation responsibility and product development responsibility. The first dimension represents the administrative process with heightened social responsibility. The second dimension represents the inherent nature and fairness of a lottery product. Based on a survey data obtained through stratified multi-stage sampling process, their results indicated that government regulation responsibility was positively associated with consumers' amount of gambling expenditure and frequency of lottery purchasing. Meanwhile, product development responsibility was negatively associated with frequency of lottery purchasing and time spends on lottery related activities. They concluded that whereas an improvement in social responsibility associated with lottery products would reduce purchasing frequency, an improvement in social responsibility associated with regulations would eventually increase consumption level in terms of absolute expenditure.

Summary

In summary, all three classes of variables reviewed above are important determinants for the demand of sports lottery. However, several variables are excluded from the current investigation, because they are either of less relevance or of less significance in the context of China. Religion is excluded because the Chinese government only permitted very limited freedom of religious belief, which subject to legal and regulatory restrictions and a predominant Chinese population apparently had no religious belief (Potter, 2003). Gender is excluded because there is minimal variance among different provinces in terms of gender composition in their populations. Ethnicity is excluded because over 91.5% of Chinese population is Han according to the Sixth National Population Census of China. Cross-border competition is not a consideration because China has a national lottery market and players are unlikely do cross border shopping on purpose. Finally, social responsibility marketing has to be excluded because there is no objective metric available for current analysis.

Table 2-1. A comparison of CWLDMC and CSLAC lottery products in China

(Unit: 10,000 *yuan*)

CWLDMC Lottery				CSLAC Lottery			
Product		Sales	Market Share(%)	Product		Sales	Market Share(%)
Instant Game							
guaguale	刮刮乐	20,044	9.2	dingguagua	顶呱刮	19,962	910
Lotto & Numbers Games							
Duo Balls	双色球	48,746	22.3	Super Lotto	超级大乐透	13,848	6.3
				Super Lotto Luck	大乐透幸运彩	208	0.1
Happy 7	七乐彩	1,547	0.7	7 Star	7星彩	2,831	1.3
kailecai	开乐彩	568	0.3	5/22 Lotto	22选5	724	0.3
3D	3D游戏	21,521	9.8	Pick 3	排列3	8,298	
				Pick 5	排列5	3,155	1.4
				High Frequency	高频游戏	19,731	
Video Lottery Terminal							
Zhongfu online	中福在线	17,014	7.8				
Sports Betting							
				Football Betting	竞彩足球	10,554	4.8
				Shengfu	足球胜平负	3,788	1.7
				Shengfu Select 9	胜平负任选9场	2,490	1.1
				Basketball Betting	竞彩篮球	1,842	0.8
				Goals of 4 Matches	足球4场进球	211	0.1
				6 Match Double Result	6场半全场胜平负	60	0.03
Local Games		18,357	8.4			3,224	1.5
Total Sales		127,797	58.4			90,924	41.6

Data source: The data of sales of CWLDMC lottery are based on the final release of CWLDMC 2011 report, and those of CSLAC lottery are based on a preliminary release of CSLAC 2011 report. The CSLAC data are not final.

CHAPTER 3
METHOD

Background about *Shengfu* game

The current investigation focused on the *Shengfu* game (Win-Tie-Lose Game, 胜负游戏). The game is the very first sports lottery in the China, and remains as the most representative form and a major player in China's lottery market. Approved by the Ministry of Finance in December 2000, the game was introduced in October, 2001 in only 12 pilot provinces (municipalities). The game then gradually expanded to other provinces and became available in all 31 provinces by September 2002. Since its origination, the game has undergone some minor changes with respect to the rules of play and prize structures. For the first 3 seasons, each drawing was composed of 13 football (soccer) matches, selected from prominent European leagues, for players to bet on. Since August 2004, 14 football matches are selected from a wider range of football competitions (See Appendix I for a sample ticket). These include but are not limited to the British Premier League, German Bundesliga, Italian Series A, Spanish Primere League, the UEFA Champions League, and the Asian Cup. The Chinese domestic football leagues are not allowed to be used in sports lottery betting.

The *Shengfu* game ticket has been sold at the fixed face value of 2 *yuan*. Figure 3-2 plots sales over time since the inauguration of the game in October 2001 to August 2012, a total of 945 draws. The game took off rapidly in its introduction phase. The sales reached a maximum of over 316 million *yuan* in draw 2003009 (March, 2003), and the second highest sale of 296 million *yuan* was found in draw 200214 (April, 2002). Only after a few seasons of irrational prosperity, however, the sales of *Shengfu* game plunged in 2004 when a new football betting lottery, Goals Betting (六场进球彩), was introduced to the market. There is a clear negative trend in the period of 2003 to 2005. Since 2006, the game entered into a more stable phase, yet still with significant draw to draw variation. During this period of time, the average sales was about 26 million *yuan* per draw (Figure 3-2). In the 2010019 draw (March, 2010), the sales hit the lowest point: 2.39 million *yuan*. In the 2007016 draw (March 2007), the sales had the highest sales of 86 million *yuan.*

Unlike the Lotto game which is usually drawn on a fixed weekday, the sports lottery depends on the schedule of the sports events. The CSLAC attempted to schedule the *Shengfu* game on a regular time interval. For the first a few seasons, with a few exceptions, the game was a weekly draw and the winning announcements were made on Mondays. The tickets would be available to purchase for one to two weeks in advance of the kickoff of the first match in the parlay. This regular drawing practice seems to have been abandoned gradually since 2008. As of sales period, it has been significantly shortened since 2005 as more draws were introduced during these seasons. As of the 2012 season, each week usually has more than one draw of the game which could be announced in any given day. The number of draws has increased from 31 in 2002 to 141 in 2011.

The *Shengfu* game is a pari-mutuel game where prizes represent a share of sales revenue. Currently, only two prizes are awarded for each drawing. To win the first prize, players have to correctly choose all of the 14 matches listed in the parlay. Those correctly predicting 13 of the 14 results win a second prize. If there are no winners of the first and/ or second prize, this money rolls over to the jackpot pool of the next drawing. The rollover is not allocated to the second prize. The sports lottery enjoys a more favorable pay-out rate: 35% of the sales is taken by the governments and 1% goes to an adjustment fund. The *Shengfu* game is of no exception: up to 65% of sales is returned to players. Yet, there is a prize cap policy for most sports lottery. Lottery players can only win a maximum of 5 million *yuan* for each winning ticket. Players may win more than 5 million *yuan* if they hold multiple winning tickets. In history of the *Shengfu* game, first prize often reaches this prize cap when the winners are very few. In the case of prize cap, the unallocated prize money will also roll over to the next drawing. Therefore, in the *Shengfu* game, the rollover can come from two sources—either there is no winner in the previous drawing(s) or there is a prize cap in the previous drawing(s). Beside the grand prize, smaller prizes are also subject to this prize cap. Throughout the history of the *Shengfu* game, the second prize reached this prize cap only twice, in draws 2005016 and 2008057 respectively.

Shengfu game players have the possibility of choosing the final result of each of the 14 matches from among three alternative results: home team win (3), tie (1), and away team win (0). For each 14-match ticket, there are 4,782, 969 (i.e., 314) combinations of the numbers. When there is an *ex ante* probability of holding a winning ticket and the results are selected randomly, then the winning probabilities for first and second prizes are $1/3^{14}$ and $14\times 1/ 3^{13} \times 2/3$ respectively. Therefore, it can be expected that, for every 4,782, 969 tickets sold, on average, there are likely one first prize winner and 28 second prize winners. This assumption, however, is rather implausible. Unlike lotto games where the winning combinations are random numbers and there exists a theoretical *ex ante* probability of having a winning ticket, the results of sports competition are not randomly chosen and the *ex-ante* probability of winning is not known. Furthermore, the issue of conscious selection, the process by which lottery players choose numbers non-randomly, is probably more prominent in sports lottery (Farrell, Hartley, Lanot, & Walker, 2000; García & Rodríguez, 2007). Players use their knowledge and available information about the teams to predict the results of competitions, and some results are easier to predict. Even when encountering difficult matches, players can effectively increase their chance of winning by buying more combinations. However, this strategy becomes more costly when the results of more matches in the parlay are subjectively difficult to predict. For example, the player needs to buy up to 243 tickets to completely eliminate the uncertainty from 5 matches. Empirically, the probability of winning a prize in *Shengfu* game is usually higher than the probability calculated based on random selection. The discrepancies are nontrivial. Over the whole period, the median of the ratio between the actual number and the calculated number for first and second prize winners are is 4.77 and 5.33 respectively. In some extreme cases, the actual probability of winning can be thousands times of that based on calculated probability. Take the drawing No.12051 as an example, there were 4,174 first prize winners when the calculated number was only 1.46. However, the mean ratio between the actual number of first prize winners and that of second prize winners is 28.7, remarkably close to the theoretical ratio of 28.

Econometric Framework

Decision Calculus

Following Conlisk (1993) and Beenstock and Haitovsky (2001) and considering the uniqueness of sports lottery as previously mentioned, we assume the individual's preference function will be an expected utility function modified to allow a consumption utility associated with sports betting. For *K* heterogeneous potential sports lottery game players, this preference value function, denoted as U_k, can be expressed by

$$U_k = U(G_i, \pi_i, P; Z_k) + \epsilon V(J, S, A),\ k=1, 2, \ldots, K,\ i=1, 2, \ldots, N, \qquad (3\text{-}1)$$

where $U()$ is an archetypal utility function, which is assumed to pass through the origin, to be increasing, and to display risk aversion; G_i denotes the monetary rewards if the individual wins the *i*th prize, π_i is the probability of winning the *i*th prize by purchasing a single ticket (i = 2 in current context), P is the price of a ticket (P = 2 *yuan* in current context), Z_k is a vector of socio-economic controls including income, age, and other variables that may influence the individual's demand for lottery ticket. The second term is the consumption utility of sports gambling, which is transformed from the excitement, suspense and fantasy associated with sports betting. Based on the literature, we assume it is a function of the jackpot size (J), prize structure (S) and the attractiveness of the matches (A). The coefficient ϵ is a positive parameter used to scale the utility of sports gambling.

G_i and P are the same for all players. As the objective probabilities of winning prizes do not exist, π_i can be interpreted as subjective probability players rationally hold toward winning a prize. In accordance with the subjective expected utility theory (Savage, 1954), the utility function from playing *Shengfu* lottery can be expressed by

$$E(U_k)=\pi_1 U(W_k+G_1-PT_k)+ \pi_2 U(W_k+G_2-PT_k)+(1-\pi_1-\pi_2)U(W_k-PT_k)+ \epsilon V(J, S, A) \qquad (3\text{-}2)$$

where W_k denotes the initial level of wealth, and T_k denotes the number of tickets bought by the individual. The individual will only participate in the game only if $E(U_k)$ is greater than 0, in which case $T_{k\geq 1}$, otherwise T_k=0.

Prize Pool

The prize pool, J, is the possible pool for all prizes. It can be expressed as

$$J = \tau S + R \tag{3-3}$$

where τ is pay-off rate; R is the unallocated prize money rolled over from previous drawings; S is the total revenue at the current drawing. S is the product of unit-price demand N and price of a ticket P, i.e., $S=P\times N$.

The prize pool devoted to the first prize, J_1, is defined as

$$J_1 = \alpha_1 \tau S + R \tag{3-4}$$

where α_1 is the proportion allocated to first prize. Therefore, the first prize is

$$G_1 = J_1 / W_1 \tag{3-5}$$

where W_1 is the number of winning tickets of first prize.

Depending on the design of the game, the equations for smaller prizes can also be specified. For simplicity of presentation, we assume this particular game has two prizes and the rollover is not allocated to the second prize, the second prize can be defined as

$$J_2 = \alpha_2 \tau S \tag{3-6}$$

where α_2 is the proportion allocated to second. Therefore, the second prize is

$$G_2 = J_2 / W_2 \tag{3-7}$$

where W_2 is the number of winners of second prize.

Risk of Prize Sharing

In any pari-mutuel games, the player faces the risk that the prize pool may be shared with other winners. A rational player, before deciding whether or not to buy a ticket or how many tickets to buy, has to consider the possibility of prize sharing. Cook and Clotfelter (1993) and Gulley and Scott (1993) show that the expected numbers of winners can be approximate by the Poisson distribution if the selection of winning combinations is random. Assuming each player buys one ticket and there are N players, the probability that there will be x winners is

$$Pois(x) = \mathrm{e}^{-pN} \frac{p\mathrm{N}^{x}}{x!}. \qquad (3\text{-}8)$$

From the perspective of player *k*, choices made by others are probabilistic. Therefore, as Cook and Clotfelter (1993) argued, the random play assumption is not critical here.

Skill Coefficient

Problem lies with the objective probability *p* is not known *ex ante* in sports lottery. It can only be estimated *ex post*. One approach to handle this problem is using the random probability as the base probability to be adjusted by a market level skill coefficient λ_t. Expertise plays a role in sports gambling, and individual players differ in their betting expertise. The skill coefficient λ_t captures only an averaged expertise level in the market at time t. The subscript t captures the fact that consumers may learn and improve their betting skills with time. A simple measure of λ_t is the median of the ratios between the actual number of winners and the calculated numbers of winners for draws prior to t. Therefore, at draw t the skill coefficient can be expressed by the following equation:

$$\lambda_t = \text{Median}\ (N_{a1}/N_{01}, N_{a2}/N_{02}, \ldots, N_{a(t-2)}/N_{0(t-2)}, N_{a(t-1)}/N_{0(t-1)}) \qquad (3\text{-}9)$$

Where N_{a1}, N_{a2},…, $N_{a(t-2)}$, $N_{a(t-1)}$ are the actual number of winners from draw 1 to draw t-1; N_{01}, N_{02}, …, $N_{0(t-2)}$, $N_{0(t-1)}$ are the calculated number of winners from draw 1 to draw t-1.

Expected Prizes

To avoid the problem of distinguishing between individuals and tickets, it is assumed that each player buys only one ticket. Then, from Eq. 3-5 and Eq. 3-9 for player *k*, the expected first prize of buying one ticket will be:

$$E(G_1) = p_1 \times (\alpha_1 \tau \mathrm{S} + \mathrm{R}) \times \sum_{x=0}^{N} \frac{1}{1+x} (e)^{-p_1 N} \frac{p_1 N^x}{x!}$$
$$= \frac{1}{N} \times (\alpha_1 \tau \mathrm{NP} + \mathrm{R}) \times (1 - e^{-p_1 N}). \quad (3\text{-}10)$$

The expected second prize of buying one ticket will be:

$$E(G_2) = p_2 \times (\alpha_2 \tau \mathrm{S}) \times \sum_{x=0}^{N} \frac{1}{1+x} (e)^{-p_2 N} \frac{p_2 N^x}{x!}$$
$$= \frac{1}{N} \times (\alpha_2 \tau \mathrm{NP}) \times (1 - e^{-p_2 N}). \quad (3\text{-}11)$$

Therefore, the expected value of winning any prize of holding one ticket will be:

$$E(G) = \frac{1}{N} \times [(\alpha_1 \tau \mathrm{NP} + \mathrm{R}) \times (1 - e^{-p_1 N}) + (\alpha_2 \tau \mathrm{NP}) \times (1 - e^{-p_2 N})]. \quad (3\text{-}12)$$

And the effective price of holding one ticket will be simply:

$$\mathrm{EP} = 1 - \frac{\mathrm{E(G)}}{\mathrm{P}} \quad (3\text{-}13)$$

or alternatively,

$$\mathrm{EP} = \frac{\mathrm{P}}{\mathrm{E(G)}}. \quad (3\text{-}14)$$

The advantage of Eq. 3-14 over Eq. 3-13 is that the former generates non-negative values of EP, which allows for natural logarithm transformation without losing information. In contrast, Eq. 3-13 will generate negative value and zero value of EP.

Relationships between Expected Value and its Determinants

From Eq. 3-12, the relationships between expected value and its determinants can be examined. Without rollover, it can be proved that the expected value converges to the pay-out rate quickly with the increasing of sales, because the partial derivative of E(G) with regard to N when R=0 is strictly positive. The relationship between N and

E(G) is more complex when there is a rollover. The sales has a positive marginal effect on expected value only if the sales is rather small. It is unlikely in reality because players will expect an increased return and buy more tickets, which in turn increase the probability of prize sharing. Further, the improved betting skills will increase the expected value. Figure 3-1 shows the relationship between the expected value, sales, and market-level skill coefficient.

Empirical Models

To examine the demand for sports lottery, two studies were conducted. The first study, using a time series data, aimed to investigate the impact of product attributes on the demand for the *Shengfu* game. The second study, using a panel data, aimed to jointly investigate the impact of demographic, marketing variables, and product attributes on the demand for *Shengfu* game.

Time Series Analysis

The first model we considered is an ordinary regression model using time series data

$$y_t=\alpha+\mathbf{x_t}\beta+\varepsilon_t,\ t=1,2,\ldots,T,$$

where y_t is aggregate nationwide sales of *Shengfu* lottery at draw *t* and x_t includes variables capturing game characteristics and structural changes of the game. Data of aggregate nationwide sales of *Shengfu* lottery since the inception of the game in 2001 to August 2012 (total 945 draws) are obtained from the prize announcements publicized by the CSLAC. Additionally, prize announcements include information about the date of the prize announcement, total sales, number of first prize winners, amount of first prize, numbers of smaller prizes winners and amount of them, unallocated prize money to be rolled over to next draws, and the matches included in the draw.

Derivation of effective price

Table 3-4 summarizes the variables included in the time series analyses. PP for all prizes can be calculated based on Eq. 3-3. The EP of each draw can be calculated based on Eq. 3-14 and Eq. 3-12. For Eq. 3-12, P has been fixed at 2, R is readily available from the prize announcements, and N is simply sales divided by 2. Over the years, τ, α_1 and α_2 were changed a couple of times (Table 3-3). Further, during 2003-2005 seasons, there were three prizes instead of two prizes. In the history of *Shengfu* game, there were occasional jackpot promotions, in which the lottery administration added a certain amount of additional money to the first prize pool, or set up a temporary special prize. Eq. 3-12 allows this type of modification. Regarding p, p_1 can be expressed as $\lambda_{1t}/3^{13}$ in the case of 13 matches per draw and $\lambda_{1t}/3^{14}$ in the case of 14 matches per draw; p_2 can be expressed as $26\lambda_{2t}/3^{13}$ in the case of 13 matches per draw and $28\lambda_{2t}/3^{14}$ in the case of 14 matches per draw. When there was a third prize, p_3 can be expressed as $312\lambda_{3t}/3^{13}$ in the case of 13 matches per draw and $364\lambda_{3t}/3^{14}$ in the case of 14 matches per draw. λ_t can be calculated based on Eq. 3-9. Table 3-3 also summarizes the historical changes of p.

Derivation of prediction difficulty coefficient

Whereas EP subsumed the market-level skill factor through its configuration, overlooked the draw-specific difficulty factor. The difficulty level associated with correctly predicting 14 matches varies draw by draw, which may have an impact on consumer purchasing behavior. Specifically, a moderately easy game will sell more because players have greater probability to win a prize. However, when the game became extremely easy, consumers may lose their interests in predicting those results. Therefore, in addition to EP, adding a variable capturing this draw-specific difficulty factor may increase the explanation power of the demand equation. A prediction difficulty/easiness coefficient (PDC) is constructed and given by $\log(\lambda_2)$. PDC actually measures the easiness of a draw because the greater the value of $\log(\lambda_2)$ the easier the game is. The reason using λ_2 instead λ_1 is because there were few undefined data points. Because through the history of the game, there were only three draws when nobody win the second prizes (i.e., λ_2 is undefined). Furthermore PDC can be approximated by a normal distribution (Figure 3-3). Additionally, to examine a potential quadratic effect of PDC, the square of PDC is also included in the regression analyses.

Derivation of ticket composition variables

Furthermore, attractiveness of the football matches is an important determinant of patron interest of the *Shengfu* lottery. The attractiveness of the matches is measured by the information of ticket combination. Because *Shengfu* game involved over 40 different leagues or football tournaments, and there are even more different combinations of these leagues, it is inefficient to dummy code all these different combinations and include them in regression analyses. An alternative approach is to classify those leagues into several manageable categories.

In order to classify these leagues, 20 football fans and experts in a sport university in China were interviewed. They were asked to evaluate popularity of 35 football leagues among Chinese fans as well as the general perception of predictability of the competition results. They were explicitly instructed not to evaluate any of those listed leagues if they were not comfortable to do so. Four measures were obtained through this process: mean score of popularity, number of experts who evaluate on popularity dimension, mean score of predictability, and number of experts who evaluate on predictability dimension. These four measures were subsequently used in a principal factor analysis. One factor was extracted with an eigen value of 3.13, explaining 97% of variances in these four variables. Based on the factor scores of the extracted variable, these leagues were classified into three groups (Table 3-5). Leagues with factor scores greater than 1 were classified as Group 1, leagues with factor scores between 0 and 1 were classified as Group 2, and leagues with factor scores below 0 were classified as Group 3.

English Premier League, German Bundesliga 1, Italian Series A, and Spanish La Liga have been four major leagues for sports betting in China. More than half of all draws are composed of matches selected from these four leagues. Particularly, one third of all draws are involved the combination of English Premier League and German Bundesliga 1 (EPL&GB), and the combination of Italian Series A and Spanish La Liga (ISA&SLL). Two dummy variables EPL&GB and ISA&SLL were generated to represent these two combinations. A third dummy variable MAJOR4 was generated to represent any other combinations of these four leagues. Furthermore, dummy variable 1TIER was generated to represent combinations of matches from the following most popular leagues: FIFA World Cup, European Championship, and UEFA Champions League. Dummy variable 2TIER represents the combinations of matches from the following less popular leagues: Ligue 1, and AFC Champions League AFC Cup, FIFA Women World Cup, Copa America, Olympic Men Soccer, European National Teams Qualifying Games, Championship, FA Cup, and Asian National Teams Qualifying Games. Dummy variable 3TIER represents the combinations of matches from the least popular leagues. Finally, a dummy variable OTHER which serves as the baseline was generated, which represent the rest combinations that were not accounted by previous dummy variables.

Additionally, because sometimes matches are selected from one league, and other times they are selected from multiple leagues. Variable NUM captures the number of different leagues a given draw involves.

Marketing and game feature dummies

To control for the historical changes of the game structure, dummy variable D3P equals 1 when there was a third prize, and 0 otherwise; dummy variable D14M equals 1 when the draw was composed of 14 matches, and 0 otherwise; dummy variable D2D equals 1 when there were two draws declared on the same day, and 0 otherwise; dummy variable DPRO equals 1 when there was a jackpot promotion, and 0 otherwise.

Panel Data Analysis

To further investigate the demand for sports lottery, a panel data containing sales of 211 draws of 30 provinces in 2011 and 2012 will be obtained from the official website of the CSLAC (www.lottery.org.cn). The response variable in the panel regression models is the sales of province i at draw t. The explanatory variables include product attributes variables and province characteristics variables (Table 3-4). All product attributes variables included in previous time series analysis but D2D, D14M, and D3P were also included in the panel data analysis. The province characteristics variables include population of a province in 2010 (POP), total dependence rate (TDR), proportion of population with completed higher education (HER) and proportion of population who are illiterate (ILR), sport development (SPORT), income (INCOME), and venue accessibility as measured by number of sports lottery outlets (NTER).

Population and population compositions

The monthly sales data is obtained from the Yearbook of the Chinese Lotteries 2011. And the PCSALES is derived by dividing SALES by the population in 2010 (POP).

The population and population composition variables, including POP, AGE0-14, AGE15-64, AGE65+, HER, and ILR, will be obtained from the Sixth National Population Census of the People's Republic of China, which was conducted in 2010. Because the sum of AGE0-14, AGE15-64, and AGE65+ is necessarily 100%, the value of one variable is predetermined by the other two. Only, AGE15-64 and AGE65+ are included in the regression because age group. Further, to increase the degree of freedom of the model, an alternative variable TDR is also considered in the model. TDR is the total dependence rate, which is calculated by the following equation.

$$TDR = (AGE0\text{-}14 + AGE65+)/AGE15\text{-}64$$

Derivation of the income variable

The National Bureau of Statistics of China does not provide the information about household income, but the Per Capita Annual Income of Urban Households (PCIUH) and Per Capita Income of Rural Households (PCIRH) are reported by the Sixth National Population Census of the People's Republic of China. Further, the proportions of rural and urban residents in the population are reported by the China Population and Employment Statistics Yearbook 2011. Therefore, INCOME is the per capita income of urban household and per capita income of rural household weighted by the proportion of urban and rural residents in the population. It is derived by the following equation:

$$INCOME = PCIUH \times \%(\text{Urban Population}) + PCIRH \times \%(\text{Rural Population})$$

Derivation of the sport variable

The sports development level is measured by the medals each province won at the 2009 China National Games (MED_{CNG}), Olympic Games (MED_{OG}), and other prominent international sports competitions (MED_{other}), and the number of professional football clubs in a province in 2010 (PRO). The variable SPORT is the factor score obtained through a factor analysis of MED_{CNG}, MED_{OG}, MED_{other}, and PRO. Table 3-2 reports the results of the factor analysis.

Venue accessibility

The main marketing factor included in the model is venue accessibility. This will be measured by the number of sports lottery terminals available in each province (NTER). NTER is obtained from the Yearbook of the Chinese Lotteries 2011.

Method of estimation

For panel data, dependent variables and regressors can potentially vary over both time (i.e., within variation) and individuals (i.e., between variation).The benefits of using panel data include increased precision in estimation by using more information and increasing degrees of freedom, allowing for unobserved heterogeneity, discriminating economic models, and providing micro foundations for aggregate data analysis (Hsiao, 2003). However, panel data methods are also more complicated, which often require adjusting standard errors of panel data estimators because each additional time period of data is not independent of previous periods. Additionally, there may be correlation across individuals, such as country panels, or state panels where spatial autocorrelation is very common (Brown & Rork, 2005; Rabe-Hesketh & Skrondal, 2012).

There are two major characteristics associated with this data set, which in turn determine the estimation strategy to be employed. First, T (i.e., 211) is large relative to N (i.e., 30). It is not possible to obtain standard errors that control for serial correlation in the error without explicitly stating a model for serial correlation (e.g., OLS using cluster-robust standard errors, or population averaged estimator (also known as Pooled FGLS estimator)). A model for serial correlation in the error, such as ARMA model for the errors, thus needs to be specified. On the other hand, given N is fixed, it is often possible to relax the assumption of independence across individuals (Cameron & Trivedi, 2005, 2010). Yet, it is possible to obtain standard errors that allow autocorrelated errors of general form by applying the method of Driscoll and Kraay (1998). Second, given the existence of time-invariant regressors (i.e., zero within variation), they cannot be identified by estimators using only within variations (e.g., OLS on the mean-difference data, or Fixed Effects Estimator). A possible approach is using Hausman-Taylor (1981) estimator, which estimates coefficient of time-invariant regressors by two-stage least squares, using those elements of time-averaged time-variant regressors that are uncorrelated with individual-specific part of the error term as instruments for time-invariant regressors (Hsiao, 2003). However, estimates of Hausman and Taylor's instrumental variable approach will be biased under dynamic model specification. Arellano and Bond (1991) proposed an IV approach using first-difference that provides unbiased and consistent estimation for dynamic models, but the time-invariant regressors will be removed by first differencing. An alternative strategy often adopted in empirical research is to use random effects models, if stronger assumptions can be made. The crucial distinction between fixed and random effects is not in the nature of the effect, but whether to make inference with respect to the population characteristics or only with respect to the effects that are in the sample (Hsiao, 2003). Finally, if the individual provinces are considered as a sample from a population of sports lottery jurisdictions, and the draws are a sample from a population of all draws, then it would make sense to associate random effects with both these factors. Unlike most application of mixed effects models (also known as hierarchical linear models), the covariance structure in this study is nonested, because individual is not nested in time and time is not nested in individual. The random intercept for provinces is shared cross all draws for a given province *i*, whereas the random intercept for draws is shared by all provinces in a given draw *t*. This type of completely crossed effects model can be estimated by the xtmixed procedure in STATA, following suggestions of Rabe-Hesketh and Skrondal (2012, p. 476).

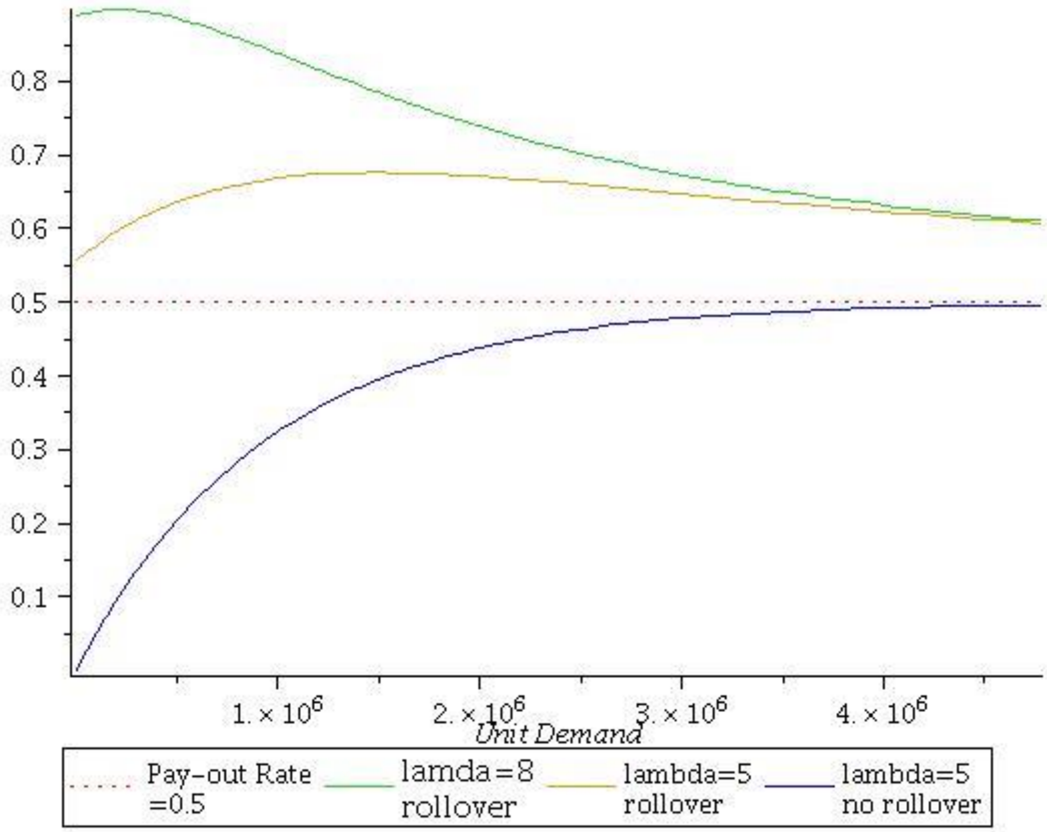

Figure 3-1. Relationships among sales, expected value, and market-level skill coefficient

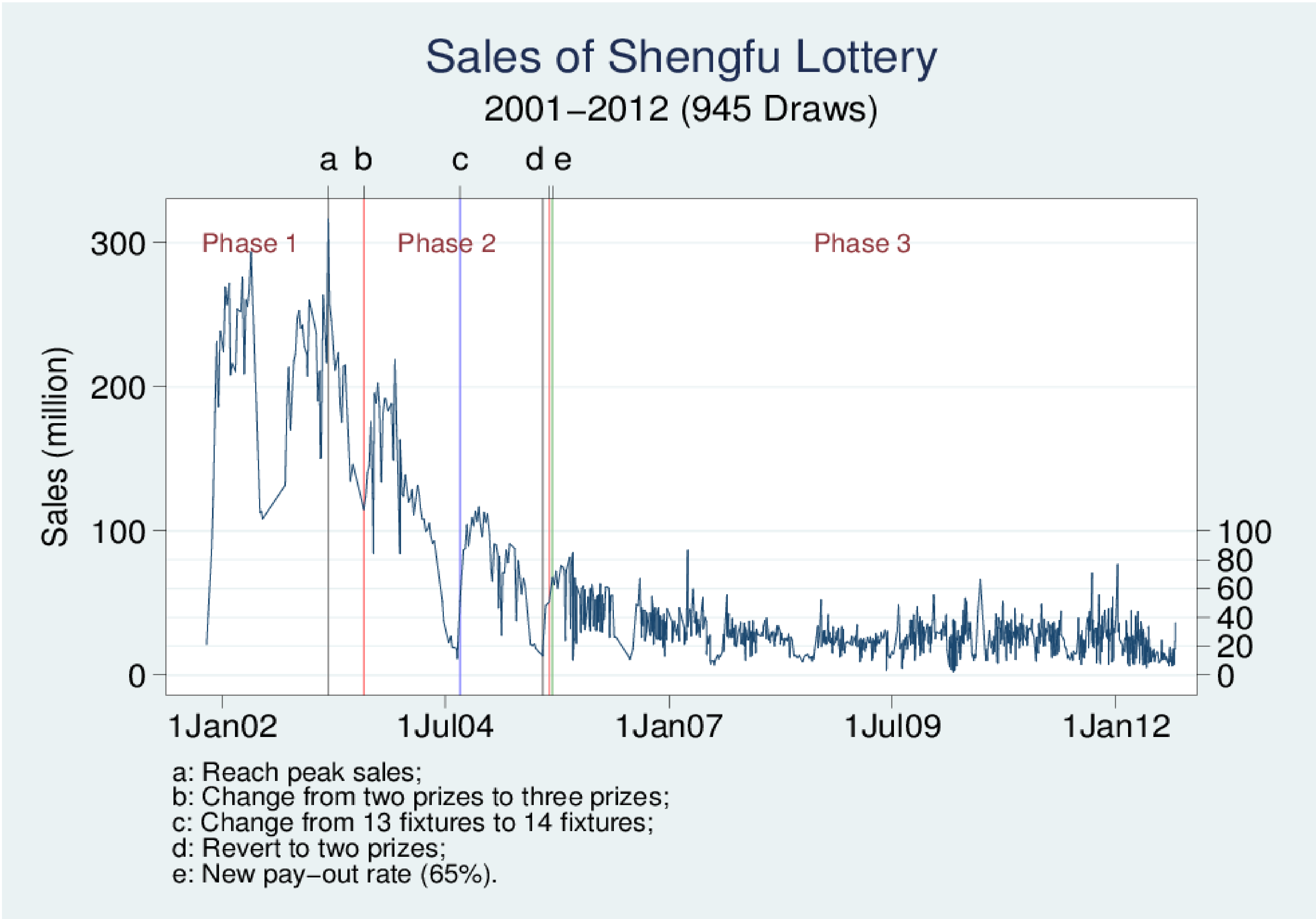

Figure 3-2. Time series line of sales of *Shengfu* game over 2001-2012

Table 3-1. Historical changes of the *Shengfu* game design

Time Period	Draws	τ	α_1	α_2	α_3	p_1	P_2	P_3
10/30/2001-06/20/2003[a]	61 (2001001-200301)	0.5	0.5	0.5	-	$\lambda_{1t}/3^{13}$	$26\lambda_{2t}/3^{13}$	-
08/03/2003-09/04/2004	50 (2003022-2004028)	0.5	0.48	0.42	0.1	$\lambda_{1t}/3^{13}$	$26\lambda_{2t}/3^{13}$	$312\lambda_{3t}/3^{13}$
09/20/2004-08/29/2005[b]	43 (2004029-2005029)	0.5	0.48	0.42	0.1	$\lambda_{1t}/3^{14}$	$28\lambda_{2t}/3^{14}$	$364\lambda_{3t}/3^{14}$
09/12/2005- [b]	2005030-	0.65	0.7	0.3	-	$\lambda_{1t}/3^{14}$	$28\lambda_{2t}/3^{14}$	-

Note: (a) During this period, there were 14 draws had a 10 million *yuan* jackpot promotion by adding a temporary third prize to the game. The EP for those draws was adjusted accordingly. (b) During this period, there were 16 draws had a jackpot promotion by adding additional prize money ranging from 3 million to 10 million *yuan* to the first prize pool. The EP for those draws was adjusted accordingly.

Table 3-2. Description of variables included in time series analyses

Variable	Definition
Response Variables	
SALES	Aggregate nationwide sales of Shengfu lottery at draw t.
Explanatory Variables	
EP	Expected effective price, it is the inverse of expected value.
PP	Expected possible prize pool.
PDC	Prediction Difficulty Coefficient.
PDCSQ	Square of PDC.
EPL&GB	Matches selected from English Premier League & German Bundes Liga.
ISA&SLL	Matches selected from Italian Series A League & Spanish La Liga.
MAJOR4	Matches selected from the four major leagues, and the combinations are other than EPL&GB and ISA&SLL.
1TIER	Matches selected from most popular leagues.
2TIER	Matches selected from less popular leagues.
3TIER	Matches selected from least popular leagues.
D2D	A dummy variable that represents simultaneously declare two draws on the same day.
DPRO	A dummy variable that represents jackpot promotion.
D3P	A dummy variable that represents a third prize.
D14M	A dummy variable that represents 14 matches.
NUM	Number of different leagues in a given draw.

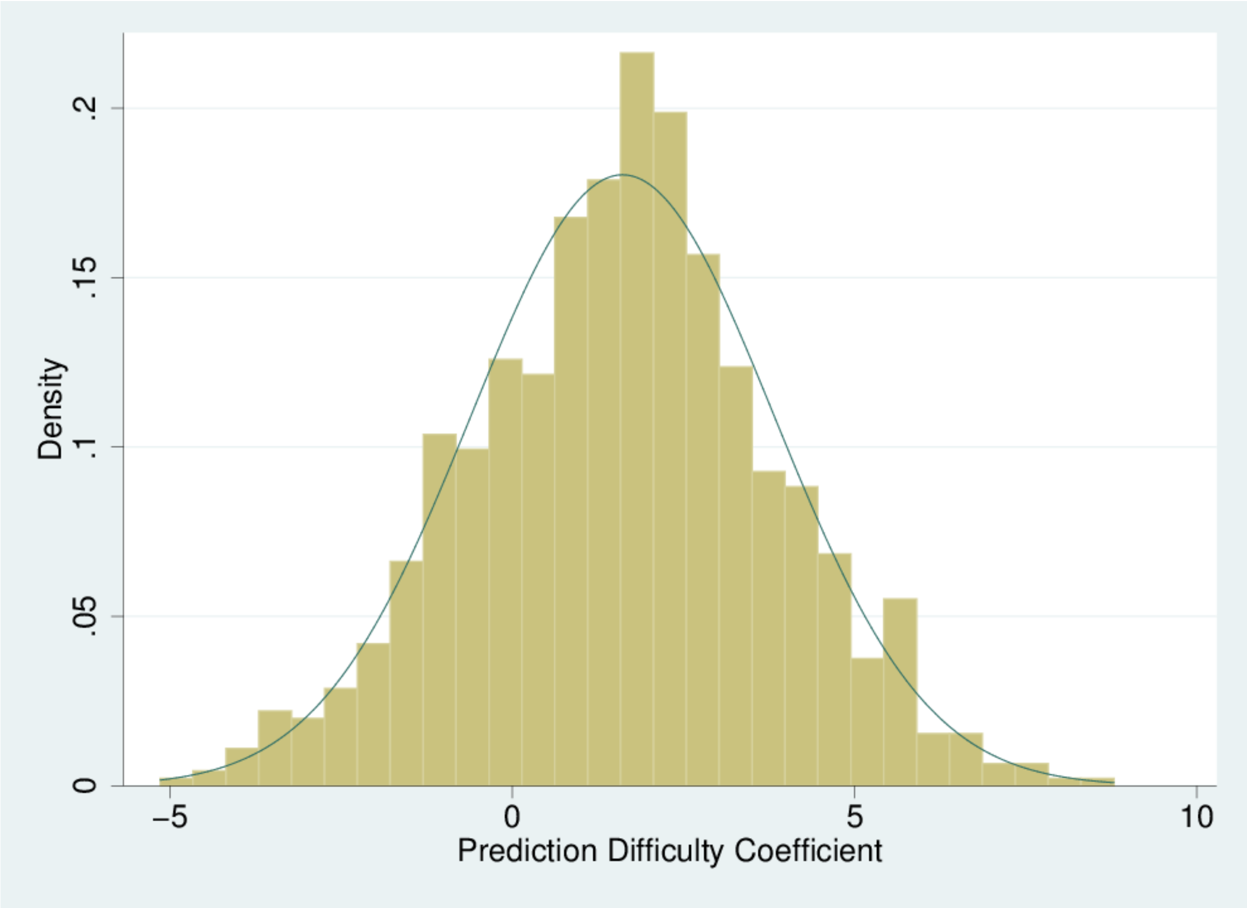

Figure 3-3. Distribution of Prediction Difficulty Coefficient as measured by log(RATIO2)

Table 3-3. Coding the combination of the matches

Leagues	Popularity	Grouping
FIFA World Cup (International)	1.41	1
Primera Division (Spain)	1.38	1
Premier League (England)	1.35	1
European Championship	1.33	1
Bundesliga 1 (Germany)	1.25	1
Serie A (Italy)	1.22	1
UEFA Champions League (Europe)	1.04	1
Ligue 1 (France)	0.96	2
AFC Champions League (Asia)	0.9	2
AFC Cup (Asia)	0.85	2
FIFA Women World Cup (International)	0.82	2
Copa America (America)	0.78	2
Olympic Men Soccer (International)	0.66	2
Qualifying (Europe)	0.28	2
Championship (England)	0.24	2
FA Cup (England)	0.11	2
Qualifying(Asia)	0.05	2
Friendship (International)	-0.18	3
Super Cup (Germany)	-0.2	3
Serie A (Brazil)	-0.32	3
UEFA Cup (Europe, Changed to Europa)	-0.42	3
Qualifying (South America)	-0.44	3
DFB Pokal (Germany)	-0.68	3
Bundesliga 2 (Germany)	-0.72	3
J1 League (Japan)	-0.77	3
Qualifying (Africa)	-0.83	3
Community Shield (England)	-0.89	3
Series B (Italy)	-1.05	3
Eliteserien (Norway)	-1.19	3
Segunda Division (Spain)	-1.33	3
CONCACAF Champions League (N/C America)	-1.36	3
Allsvenskan (Sweden)	-1.37	3
J2 League (Japan)	-1.39	3
Eerste Divisie (Netherlands)	-1.4	3
Veikkausliiga (Finland)	-1.4	3

Table 3-4. Description of variables included in panel data analyses

Variable	Definition
Response Variables	
SALES	Sales of *Shengfu* game for province i at draw t
Product Attributes Variables	
EP	Expected effective price, it is the inverse of expected value.
PDC	Prediction Difficulty Coefficient.
PDCSQ	Square of PDC.
EPL&GB	Matches selected from English Premier League & German Bundes Liga.
ISA&SLL	Matches selected from Italian Series A League & Spanish La Liga.
MAJOR4	Matches selected from the four major leagues, and the combinations are other than EPL&GB and ISA&SLL.
1TIER	Matches selected from most popular leagues.
2TIER	Matches selected from less popular leagues.
3TIER	Matches selected from least popular leagues.
D2D	A dummy variable that represents simultaneously declare two draws on the same day.
NUM	Number of different leagues in a given draw.
Province Characteristics Variables	
POP	Total population of each province in 2010.
LPOP	Natural logarithm transformation of POP.
TDR	Total Dependence Rate.
HER	Proportion of population with completed higher education.
ILR	Proportion of population who are illiterate.
SPORT	A derived variable measuring sport development.
INCOME	A derived variable measuring average income level in the province.
LINCOME	Natural logarithm transformation of INCOME.
NTER	The number of sports lottery outlets in each province.
LNTER	Natural logarithm transformation of NTER.
Intermediate Variables	
AGE0-14	Proportion of age group (0-14) in the population.
AGE15-64	Proportion of age group (15-64) in the population.
AGE65+	Proportion of age group (15-64) in the population.
PCIUH	Per Capita Annual Income of Urban Households in 2010.
PCIRH	Per Capita Income of Rural Households in 2010.
MED_{CNG}	Medals each province won at the 2009 China National Games.
MED_{OG}	Medals each province won at all Olympic Games.
MED_{other}	Medals each province won at all other prominent events.
PRO	Number of professional football clubs in a province in 2010.

Table 3-5. Descriptive statistics and factor solution for deriving SPORT variable

Construct and Items	*M*	*SD*	*MIN*	*MAX*	λ
MED_{CNG}	45.32	43.39	2	153	0.99
MED_{OG}	9.19	9.81	0	33	0.95
MED_{other}	36.13	34.81	2	136	0.96
PRO	1.03	1.30	0	5	0.77
Eigen Value					3.42
Variance Explained					94.4%

CHAPTER 4
RESULTS

Results of Time Series Analysis

Preliminary Analysis

Figure 3-2 shows the historical sales of *Shengfu* lottery from 2001 to August 2012 for all 945 draws. Table 4-1 further summarizes the overall descriptive statistics for all 945 draws as well as those by the phase. The average sales of the lottery for the three phases, namely introduction, recession, and equilibrium were 207.5 million, 113.5 million, and 27.3 million *yuan*. The variances of sales, judged by the values of standard deviation, became significantly narrower with time. The average first prizes were 1.75 million, 1.15 million, and 1.20 million. And the average second prizes were 90590, 116325, and 117263 *yuan*. The cost for buying the probability distribution of winning 1 *yuan* was 0.48 *yuan* in the first phase, and increased to 0.53 *yuan* in the second phase, and then decreased to 0.27 *yuan* in the third phase. More interesting were the statistics of the market-level skill coefficients. The skill coefficient of winning a first prize (λ_1), as measured by the median ratio between actual number of first prize winners and theoretical number, grew from .66 to 2.96 and then to 5.31. A similar trend was also found with skill coefficient of winning a second prize. Figure 4-1 shows the historical change of the market-level skill coefficients.

It is possible to explore some of the relationships between the demand for *Shengfu* lottery and its primary determinants through preliminary analysis. For example, rollover is often regarded as the driving force for both effective price and jackpot pool. By plotting sales against rollover, we can see a clear positive relationship between sales and rollover. The left column of Figure 4-2 shows this positive correlation and almost all points are within the 95% confidence interval of the predicted values. A more interesting question, however, is how much of the sales can be attributable to rollover? By differencing the current sales and the sales of the previous draw, we obtained sales difference. The right column of Figure 4-2 plots the sales difference against rollover, and it tells a completely different story. Sales difference was barely related to rollover, a finding that goes against the findings of previous studies. A positive impact is more evident when the rollover is sufficiently large, but we have too scarce data points to conclude this. A comparison of these two plots suggests that this strong positive correlation between sales and rollover may be an artifact of serial autocorrelation. As rollover is determined in preceding draw, a higher rollover is often the result of higher sales in the preceding draw. Due to serial autocorrelation (i.e., the current sales are highly associated with preceding sales), therefore, we observed a positive correlation between sales and rollover.

We also explored the impact of different leagues on sales. English Premier League, German Bundesliga 1, Italian Series A, and Spanish La Liga have been four major leagues for sports betting. In our sample, one third of the draws involved the combination of English Premier League and German Bundesliga 1 (EPL&GB), and the combination of Italian Series A and Spanish La Liga (ISA&SLL). We used EPL&GB and ISA&SLL to illustrate the impact of leagues. Overall, lottery draws involving EPL&GB matches sell better than those involving ISA&SLL matches. As leagues represent the consumption value of the game, this suggests that sports lottery has consumption value for players. Furthermore, after controlling consumption value variable, the positive effect of rollover on sales is now evident. Overall, draws with rollover sell better than those without rollover. The claimed spurious zero correlation between rollover and sales difference is likely due to the failure of considering the league information. This preliminary analysis suggests that autocorrelation, consumption value of the game, and rollover need to be considered to reach a valid conclusion. Figure 4-3 shows these preliminary results.

Stationarity, Autocorrelation, and Dynamic Specification

Prior to any formal analysis involving time-series, it is necessary to investigate the stationarity properties of the variables. A stationary series (i.e., mean reverting) fluctuates around a constant long-run mean, which implies the series has a finite variance which does not depend on time. On the other hand, if a series is non-stationary (i.e., ever-changing), it has no tendency to return to a long-run deterministic path and the variances of the series are time-dependent. In a marketing setting, a non-stationary series implies an evolving market, where the sales wander freely in one direction or another, or has a seasonal pattern (Hanssens, Parsons, & Schultz, 2001). The tests of stationarity, known as unit root tests, check whether the autoregressive polynomial ($1-\varphi L$) has a root on the unit circle. The Augmented Dickey-Fuller (ADF) test is used to assess the stationarity of sales, which readily rejected the null hypothesis of existence of a unit root at 1% critical value level ((Z(t)=-5.7, 1% critical value=-3.43, MacKinnon approximate p-value for Z(t)=.0000). The result of ADF test suggests that the *Shengfu* lottery market has been stationary since its initial inception in 2001. There is no obvious trend of growth or declining due to exogenous shocks, such as effective marketing, population growth, introduction of competitive products, or fatigue (Hanssens et al., 2001).

After confirming the stationarity of the market, the behavior of the time series is determined by Box and Jenkins' (1976) three-step modeling procedure, which consists of identification, estimation, and diagnostic checking. First, a candidate ARIMA process is selected by inspecting the autocorrelation function (ACF) and partial autocorrelation function (PACF) of the original series. The ACF at lag *k* is simply the correlation of two data points that are *k* periods apart. The PACF at lag *k* is a similar correlation, but it holds constant all *k*-1 observations between two data points. The ACF plot of Figure 4-4 shows that the series of lottery sales has a slow "die out" pattern, suggesting a strong autocorrelation. Further, the PACF plot shows two obvious spikes in the series, which suggests an AR(2) process. The second step involves estimating the model's parameters and saving the residuals. If the model is adequate, the residuals will be whitened (i.e., the residuals are white noise) and the ACF-PACF should be flat without any spikes. However, the ACF-PACF of the residuals still show significant spikes, and both Bartlett test (B=1.65, p=0.0086) and Portmanteau test (Q=143.19, p=.0000) for white noise suggest residuals are significant deviates from white noise, thus the original AR(2) model is not appropriate. Even by increasing the number of lags to 3 and 4 did not completely whiten the residuals (Bartlett test failed to reject the null of white noise, but the Portmanteau test did in both cases).

Box and Jenkins (1976) also suggested taking the logarithm of a heteroscedastic series in order to obtain variance homogeneity. Box and Jenkins' three-step modeling procedure was repeated on the natural logarithm transformed sales data. The PACF plot showed four spikes in the transformed series, which suggested an AR(4) process (Figure 4-5). A further inspection of the ACF-PACF of the residuals showed no significant spikes. Both Bartlett test and Portmanteau test for white noise this time reject the null of white noise, suggesting the AR(4) model is appropriate. There are essentially two ways of dealing with serial correlation: one approach is to include a lagged dependent variable in the set of independent variables; and the other is to estimate a model via serial correlation errors (Beck & Katz, 1996). Because over-time persistence in the data constitutes substantive information, and can have theoretical explanation (e.g., Farrell et al., 1999), the first approach is more preferable in this study. Therefore, in the following regression analysis, the natural logarithm transformed sales data would be used as response variable, and four lags would be included in the right side of equation.

Ordinal Least Squares Results

Previous studies suggest expected jackpot size and expected effective price are two underlying drivers for lottery demand. The hybrid model including both effective price and jackpot size is considered first (Column 1 of Table 4-2). As expected, the jackpot size had a significant positive impact on the demand. But surprisingly, the coefficient of effective price was also positive, which means people buy more tickets when the price is higher. This result is inconsistent with microeconomic theory and previous studies in the field (e.g., Clotfelter & Cook, 1990; Forrest et al., 2000; Garrett & Sobel, 2004). Including ticket composition and prediction difficulty variables (Column 2), and marketing variables (Column 3) in the regression revealed that the positive sign of effective price persists. Furthermore, the coefficient on the prediction difficulty was negative, which means people buy more tickets when the games are more difficult to predict when other variables are held constant. The coefficient on promotion was negative, suggesting jackpot promotion was associated with a decrease in sales holding other variables constant. Across all three regressions, after controlling jackpot size, the magnitude of four lags of sales became rather small compared with the results of previous time series analysis. These lend us little confidence in the hybrid model. A further examination of the zero-order correlation matrix among sales and jackpot size revealed that the simple bivariate correlation was 0.91.This is not surprising because the jackpot pool was directly calculated based on sales. They would have been perfectly correlated if there were no prize cap policy. The only deviation from perfect correlation is induced by the prize cap policy. Cook and Clotfelter (1993) reported a similar result when they tried to include expected value and jackpot size in a regression to estimate the demand for a state lottery in the U.S. Without a valid instrumental variable or proxy variable, it is impossible to estimate the expected jackpot pool model. Furthermore, in the current context where a prize cap is imposed, it is speculated jackpot size will not matter as much as in traditional lotto games. Therefore, we subscribe to the effective price model.

Column 4 of Table 4-2 shows the baseline effective price model (M1) which only include four lags of sales and effective price. Column 5 extends the model by including ticket composition and prediction difficulty variables (M2). Column 6 further extends the model by including marketing variables (M3). All three models fit the data reasonably well with 70.8% to 81.8% variances explained. Further, a Breusch-Godfrey LM Test for autocorrelation suggests that M2 suffer from an autocorrelation problem, whereas M1 and M3 do not. A Breusch-Pagan test for heteroskedasticity suggests all three models have heteroskedastic residuals, and thus heteroskedasticity-robust standard error are used and reported in Table 4-2.

After dropping the jackpot size variable in the regression model, across all three regressions the coefficient of effective price had a negative sign as microeconomic theory predicted. The OLS estimated elasticity around -0.56 in the final regression, suggesting one percent decrease in price is associated with 0.56 percent increase in sales. Across all three regressions, the four lags of sales were significantly related to the current sales.

The ticket composition had a significant impact on sales. According to the results developed by Halvorsen and Palmquist (1980) and Kennedy (1981), an estimate of the percentage impact of a dummy variable in a log transformed model is given by g=100(exp(b-v(b)/2)-1), where b is estimated coefficient on a dummy variable and V(b) is the estimated variance of b. Compared to a mixture of all kinds leagues, draws composed of EPL&GB were associated with 100*(exp(0.484-0.04*0.04/2)-1) percent change in sales, approximately 62.12% increase in sales. Likewise, draws composed of ISA&SLL, prominent cup games (1TIER), other major league combinations (MAJOR4) were associated with 15.64%, 9.25%, and 62.01% change in sales, respectively. Whereas EPL&GB, ISA&SLL, MAJOR4 and 1TIER were all positively associated with sales, 2TIER and 3TIER were negatively associated with sales. Draws composed of minor leagues and middle leagues were associated with approximately 27.85% and 19.81% decrease, respectively.

Prediction difficulty coefficient was also significantly related with sales, but with a relative small coefficient (0.0159). It means that a one unit change in prediction difficulty coefficient is approximately associated with 1.59% (i.e., $e^{0.0159}$-1) change in sales. The quadratic term of prediction difficulty coefficient is not significant at 5% confidence level.

Draws that were declared on the same day sell significantly less. The impact of simultaneity was associated with 14.99% decrease in sales. Draws with jackpot promotion sold about 24.29% more. Changing a two-prize structure to a three-prize structure was associated with 15.22% increase in sales. Compared to draws when only 13 matches were included, draws consisting of 14 matches sold 41.16% less. The number of different leagues included in a draw (NUM) was found negatively associated with sales. Adding one more league to the ticket was associated with 4.18% decrease in sales (i.e., $e^{-0.04}$-1).

Instrumental Variables Results

As discussed, the effective price is necessarily endogenous in the regression model due to simultaneity. Furthermore, as the expected jackpot pool was left out of the current model, the OLS model may thus also suffer omitted variable issue. The conventional instrumental variable approach was therefore chosen to correct the endogeneity bias of OLS. Following previous studies (Forrest et al., 2000; García & Rodríguez, 2007), the amount of rollover was used to instrument effective price. Column 7 of Table 4-2 reports the second stage results of instrumental variables estimation. The model overall fits the data well, with 81.48% variance in sales explained by this set of explanatory variables. The general specification test of serial correlation proposed by Cumby and Huizinga after instrumental variables estimation failed to reject the null of nonautocorrelation at the 5% confidence level. All coefficient estimates from instrumental variables approach were in the same direction as OLS, and the magnitude of most coefficient estimates remained close, with the exception of effective price. The demand for sports lottery was more elastic than the OLS suggested. The coefficient estimate of effective price from instrumental variable approach was about 1/2 larger than that obtained from OLS, suggesting OLS estimation bias towards zero in this case. The point estimate of elasticity with regard to effective price was -0.78, and the corrected standard error 0.075.

In terms of the first stage, the centered R^2 was 0.83, and the *F* statistic was 162.30. The coefficient estimate of the instrument was significant at .01 confidence level. These suggest that the first stage is adequately strong, and rollover is relevant. It can be a good instrument for effective price. However, the validity of an instrument also relies on a second condition: instrument exogeneity. It is a strong assumption that rollover has no partial effects on sales and is strictly exogenous to the equation. Beenstock and Haitovsky (2001) have shown the lottomania phenomenon driven by multiple rollovers. They showed a direct effect of rollover on consumption. Instrument exogeneity condition also means that the instruments should not correlate with the disturbances. Assuming jackpot pool is indeed a driving factor, omitting expected jackpot pool in the equation means expected jackpot pool is in the disturbances. Therefore, as rollover is determinant of jackpot pool, they are correlated. Thus, the exogeneity assumption can be violated under this alternative theoretical framework. Nevertheless, the instruments may hold if we are willing to assume rationality in lottery consumption behavior. Consumers are not spontaneous, not impulsive, but rational. Under this assumption, after partialing out effective price, jackpot pool should not impact sales. And we have more credibility by using rollover as an instrument in the estimation.

Using CAP as Instrument

Because prize cap is imposed on the game, it causes exogenous variation in the expected prize. A further investigation of the occurrence of cap reveals that it can hardly be predicted by using the information of previous sales level, ticket composition, prediction difficulty, and marketing variables. The success rate of a logit regression relating occurrence of cap to all the explanatory variables included in previous studies is 0/53, which means the occurrence of CAP is quite random and unpredictable. This lends our confidence to the exogeneity of CAP. As CAP is potentially a weaker instrument for effective price, limited information maximum likelihood (LIML) method, which is more robust to the presence of weak IV, was used (Baum, Schaffer, & Stillman, 2007).

To assess the strength of the first stage regression, a variety of test statistics were used. The centered R^2 was 0.36, and *F* statistic was 46.36. The coefficient estimate of CAP is significant at .01 confidence level. Because we have one instrument for one endogenous variable, the model is just-identified. Further, the Cragg-Donald Wald *F* statistic is large (28.25). By comparing it to the 10% maximal LIML size (16.38) of Stock-Yogo weak ID test critical values for K1=1 and L1=1, the null hypothesis of weak identification can be rejected. The robust Kleibergen-Paap Wald rk *F* statistic (18.42) also rejected the null of weak identification, suggesting that the first stage was strong. These lend great confidence to the results of the model.

Column 8 of Table 4-2 reports the results of second stage of the model. Not surprisingly, the magnitude of coefficient estimate of effective price is even larger, with elasticity around -1.01. This means that a one percent increase in price will lead to one percent decrease in sales. A trade-off of this model, however, is a larger standard error (0.39). Furthermore, coefficient estimates of all the rest variables are very close to previous analysis.

Results of Panel Data Analysis

Because dependent variables and regressors can potentially vary over both time (i.e., within variation) and individuals (i.e., between variation), cross-sectional analysis and pure time series analysis usually suffer from the estimation bias arising from heterogeneity or selection. In our sample, the individuals are provinces in China except Tibet. We can observe substantial within and between variations of sales of S*hengfu* lottery (Figure 4-6). Whereas the dependent variables and its four lags necessarily vary over both time and individuals, the included regressors can be time-invariant or individual-invariant. For example, the effective price of any given draw was the same for every individual (i.e., individual-invariant) but the income level was considered stable over the period from 2010 to 2011 of any given individual (i.e., time-invariant). Table 4-3 presents the descriptive statistics of dependent variables and included regressors. Further, simply regressing sales on effective prices reveals substantial variability in coefficient estimates (Figure 4-7). Panel data methods, therefore, are desirable.

Pooled Models

For completeness, a natural starting point is a class of pooled models, which specify the same regression model for all individuals in all draws. The first pooled model (PM1) is a static regression model using OLS with cluster-robust standard error. The second model (PM2) is pooled OLS with standard errors assuming general serial correlation in the error to four lags and correlation over states (i.e., Driscoll-Kraay (1998) standard errors; Hoechle, 2007). The third model (PM3) is a dynamic model by including four lags of dependent variable in the right side and estimated by the Pooled Feasible Generalized Least Squares estimator (PFGLS). In principle, PFGLS is the best estimator for pooled models (Cameron & Trivedi, 2010, p. 268). Column 1-3 of Table 4-

8 report the results of these three models. Coefficient estimates of PM1 and PM2 are the same. The differences lie with their standard errors. The standard errors of time-variant variables of PM2 are about 4 times larger than those obtained by PM1, and those of time-invariant variables of PM2 are about 4 times smaller than those obtained by PM1. However, as mentioned, both models suffer from an autocorrelation problem. A Wooldridge test for autocorrelation in panel data (Drukker, 2003; Wooldridge, 2002) readily rejects null of no first-order autocorrelation (F(1,29)=5.9, p=0.02). There are noticeable changes in the coefficient estimates of PM3. Particularly, after controlling the lags of sales in the model, the magnitude of those time-invariant variables decreased drastically. For example, the point estimate of income elasticity decreased from 2.03 in PM1 and PM2 to 0.11 in PM3.

Fixed Effects Models

The second class of models is fixed effects models, which explicitly consider the individual-specific effects. The first FE model (FE1) is static model fitted with Least Squares Dummy Variables (LSDV) approach of including a set of dummy variables, here for each province. The second model (FE2) is a dynamic version of FE1. To examine the coefficients of time-invariant variables, the fourth model (FE3) is estimated by Hausman and Taylor's (1981) approach. And the fifth model (FE4) is estimated by Arellano and Bond's (1991) approach to account for dynamic specification. Column 4-7 of Table 4-8 report the results of these four models. As discussed, the FE1, FE2, and FE4 were unable to identify time-invariant regressors. The coefficient estimates of those time-variant variables of FE1 are same as those of PM1. The coefficient estimates of FE3 are same as those of PM1. The coefficient estimates of FE2 and FE4 are generally consistent. The key insight is that the intra-class correlation (IC) of FE1 is 0.876, suggesting that 87.6% variances of sales are due to differences across provinces. The IC of FE2 is 0.699, suggesting that even after controlling historical sales level (i.e., four lags of sales), 69.9% variances are still attributable to regional differences. FE3 does not account for dynamics but includes time-invariant variables. The IC of FE3 dropped to 0.774, meaning about 10.2% (i.e., 0.876-0.774) variances are explained by those time-invariant variables. The key insight from FE4 is that including four lags of sales in the model is likely appropriate. Arellano-Bond test for zero autocorrelation in first-differenced errors reject the null of no autocorrelations at order 1 (z=-2.41, p=.016) but not at higher orders (z=.11, p=.91 at order 2; z=-.67, p=.50 at order 3). Therefore, we can conclude that after including four lags, there is no serial correlation in the error as desired.

Two-Way Random-Effects Model

The third class of models is a dynamic two-way random-effects model (RE1) using MLE via EM algorithm (Baltagi, 2005; Rabe-Hesketh & Skrondal, 2012; Rubin & Szatrowski, 1982). Column 8 of Table 4-8 reports the results of the model. The coefficient estimates of RE1 are generally consistent with previous studies: (a) The estimated elasticity with regard to effective price is about -1.0; (b) Ticket combination variables have significant impact on the demand. Specifically, major league matches sell more and minor league matches sell less; (c) Prediction difficulty coefficient is marginally significant at 10% confidence level, and the magnitude is rather small (0.04); (d) Simultaneous selling two draws at a time reduce sales by about 21.4% (i.e., exp(-0.237-0.088*0.088/2)-1 percent) averagely for each draw; (e) Diversifying the draw by including matches from one more league has a small negative impact on sales, reducing sales by about 5.4% (i.e., exp(-0.055)-1); (f) Population was not found a significant predictor of sales after controlling all the other variables; (g) Dependence rate is significantly related to sales, one percent increase in TDR is associated with about 2.1% increase in sales; (h) The demand elasticity with regard to income is about 0.39, quite different from previous models. In a cross-sectional setting using aggregate monthly sales, we found the income elasticity was a positive 1.59. The estimates of PM1, PM2 and FE3 were about a positive 2.03, which did not include lags in their models; (g) HER, ILR, SPORT, and NTER were found not significant related to sales. The estimated residual standard deviation between provinces was 0.15, and the estimated residual standard deviation between draws was 0.33. The remaining residual standard deviation, not due to additive effects of provinces and draws, was estimated as 0.20. The residual intra-hclass correlation (ICC) for provinces was estimated as

$$\hat{\rho}(province) = \frac{0.15^2}{0.15^2 + 0.33^2 + 0.20^2} = 0.13$$

and the residual ICC for draws was estimated as

$$\hat{\rho}(draw) = \frac{0.33^2}{0.15^2 + 0.33^2 + 0.2^2} = 0.64$$

Hence, there is a high correlation over draws within provinces and a small correlation over provinces within draws.

Instrumental Variables Results

The fourth class of model used instrumental variables approach because expected price is endogenous in the model. FE3 and FE4 are IV models, which use lags of the endogenous regressor (i.e., EP) as instruments. As discussed previously, rollover and the dummy variable of prize cap (CAP) are used as instruments for endogenous variables respectively in two one-way random-effect models (RE2 and

RE3). Column 9-10 of Table 4-8 report the results of estimates. RE2 using rollover as an instrument reports an elasticity of -1.19 (*SE*=.029), and RE3 using CAP as an instrument reports an elasticity of -0.94 (*SE*=.13). Both results are not very different from previous analysis, which lend confidence to the results.

Table 4-1. Descriptive statistics for time series data

	Mean	SD	Min	25%	Median	75%	Max
Overall							
SALES (million *yuan*)	45.82	53.29	2.39	20.36	27.36	40.82	316.43
First Prize (thousand *yuan*)	1259.12	2073.89	0.00	38.26	388.76	1611.21	38800.00
Second Prize (thousand *yuan*)	115.78	433.33	0.00	2.92	11.08	49.22	5000.00
Expected Value	1.38	0.38	0.89	1.28	1.28	1.28	4.63
Effective Price (1/EV)	1.53	0.31	0.43	1.56	1.56	1.57	2.24
Total Jackpot	29.02	30.70	0.00	10.70	17.60	34.10	223.00
STAGE 1							
SALES (million *yuan*)	207.55	62.97	21.21	186.17	220.54	253.02	316.43
First Prize (thousand *yuan*)	1752.13	1900.97	0.00	110.51	1175.12	2913.33	5000.00
Second Prize (thousand *yuan*)	90.59	164.49	0.28	4.79	36.16	106.79	998.28
Expected Value	1.04	0.09	0.98	0.98	0.98	1.07	1.34
Effective Price (1/EV)	1.94	0.15	1.50	1.86	2.04	2.04	2.04
Total Jackpot	111.47	39.35	10.20	102.00	124.00	132.00	223.00
STAGE 2							
SALES (million *yuan*)	49.27	46.18	2.22	22.66	29.83	56.20	256.19
First Prize (thousand *yuan*)	1420.00	2495.62	0.00	48.81	449.73	1917.27	38800.00
Second Prize (thousand *yuan*)	121.70	480.24	0.00	2.62	11.28	48.77	5000.00
Expected Value	1.36	0.41	0.89	1.26	1.28	1.28	4.63
Effective Price (1/EV)	1.57	0.33	0.43	1.56	1.56	1.59	2.24
Total Jackpot	31.06	26.71	0.00	13.90	20.90	39.60	178.00
STAGE 3							
SALES (million *yuan*)	24.84	11.40	2.39	15.95	24.75	31.29	76.72
First Prize (*yuan*)	1046.81	1547.51	0.00	23.72	331.48	1341.17	5000.00
Second Prize (*yuan*)	112.68	404.17	0.00	2.90	9.87	43.17	4774.88
Expected Value	1.44	0.35	0.93	1.28	1.28	1.29	3.52
Effective Price (1/EV)	1.44	0.24	0.57	1.55	1.56	1.56	2.15
Total Jackpot	18.05	15.60	0.00	8.29	15.40	21.40	109.00

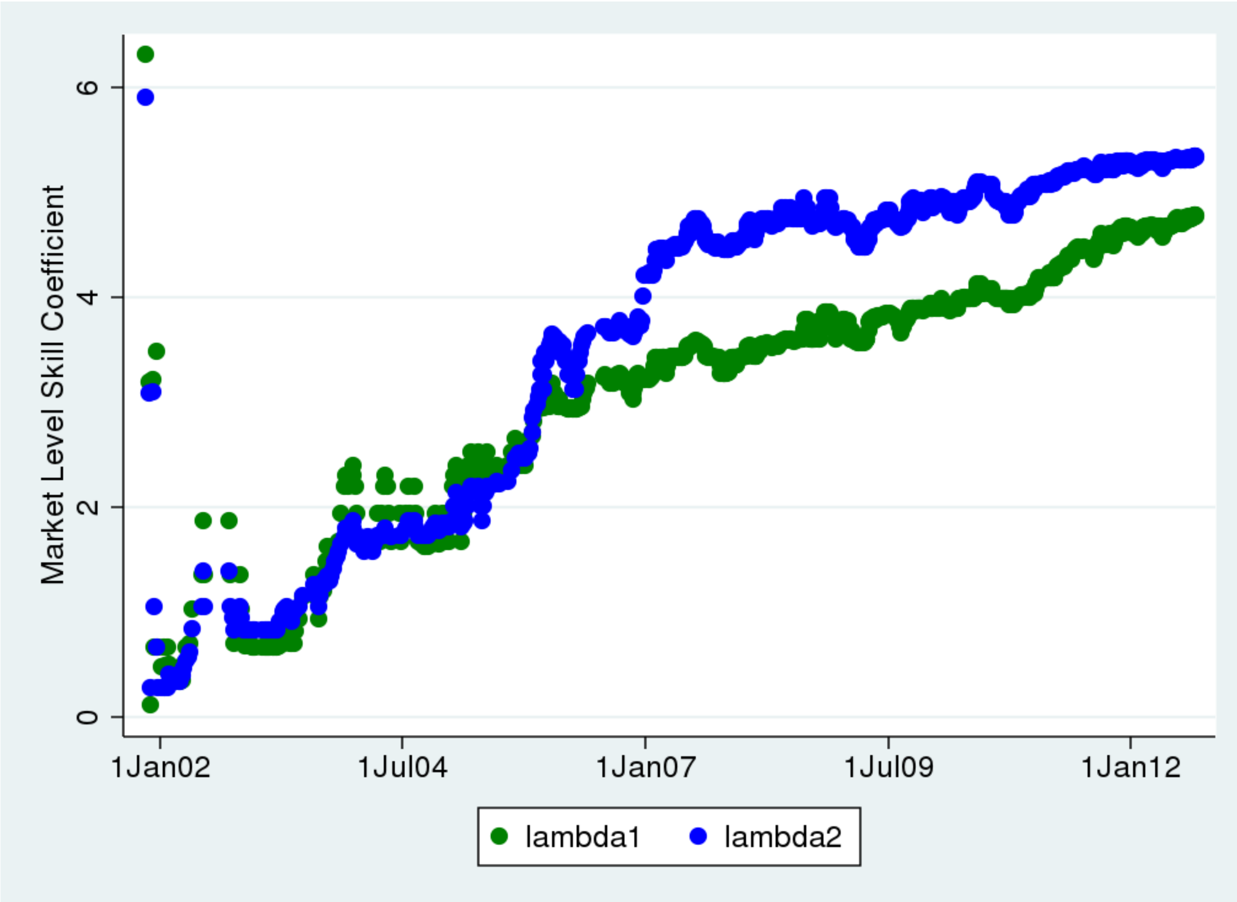

Figure 4-1. Historical change of market-level skill coefficients (λ_1, λ_2)

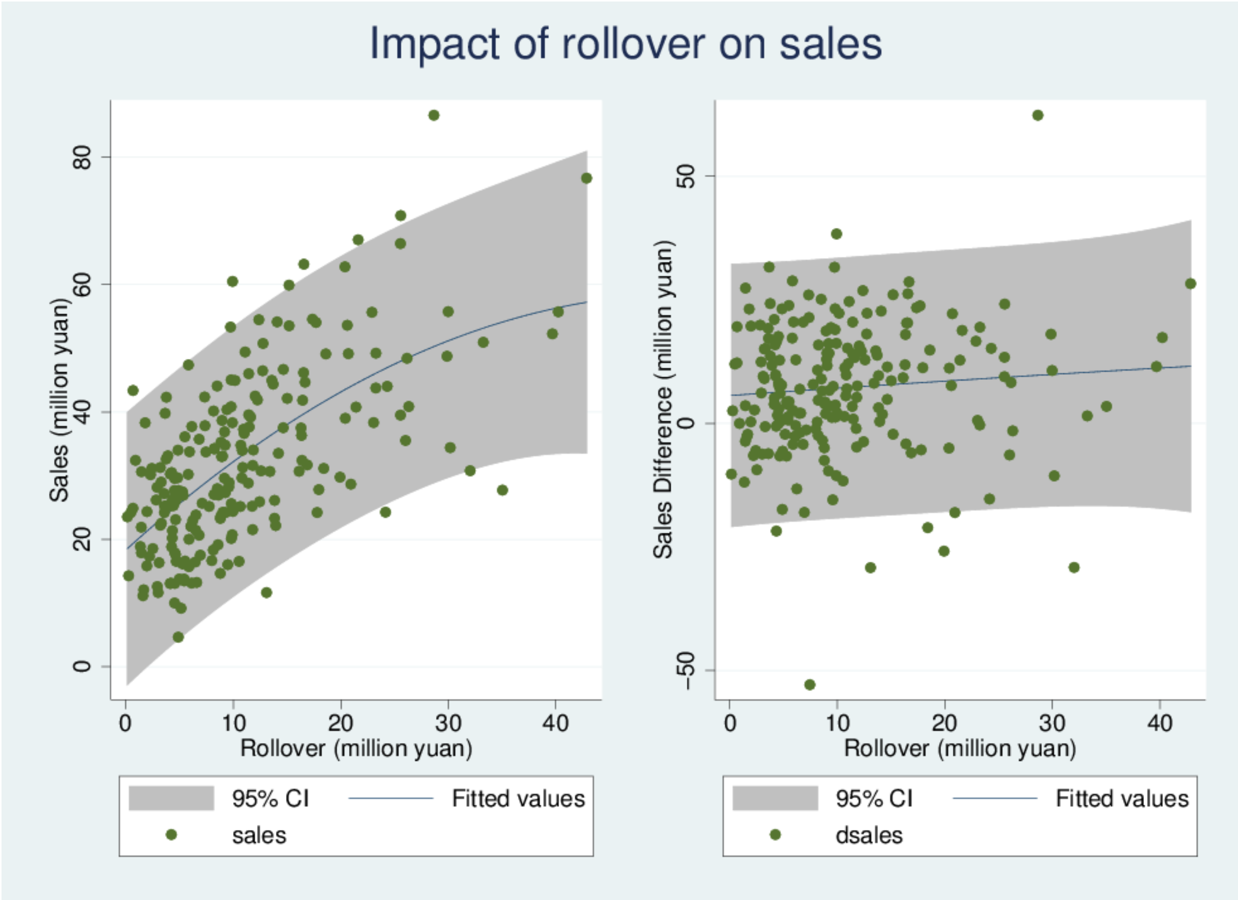

Figure 4-2. Impact of rollover on demand

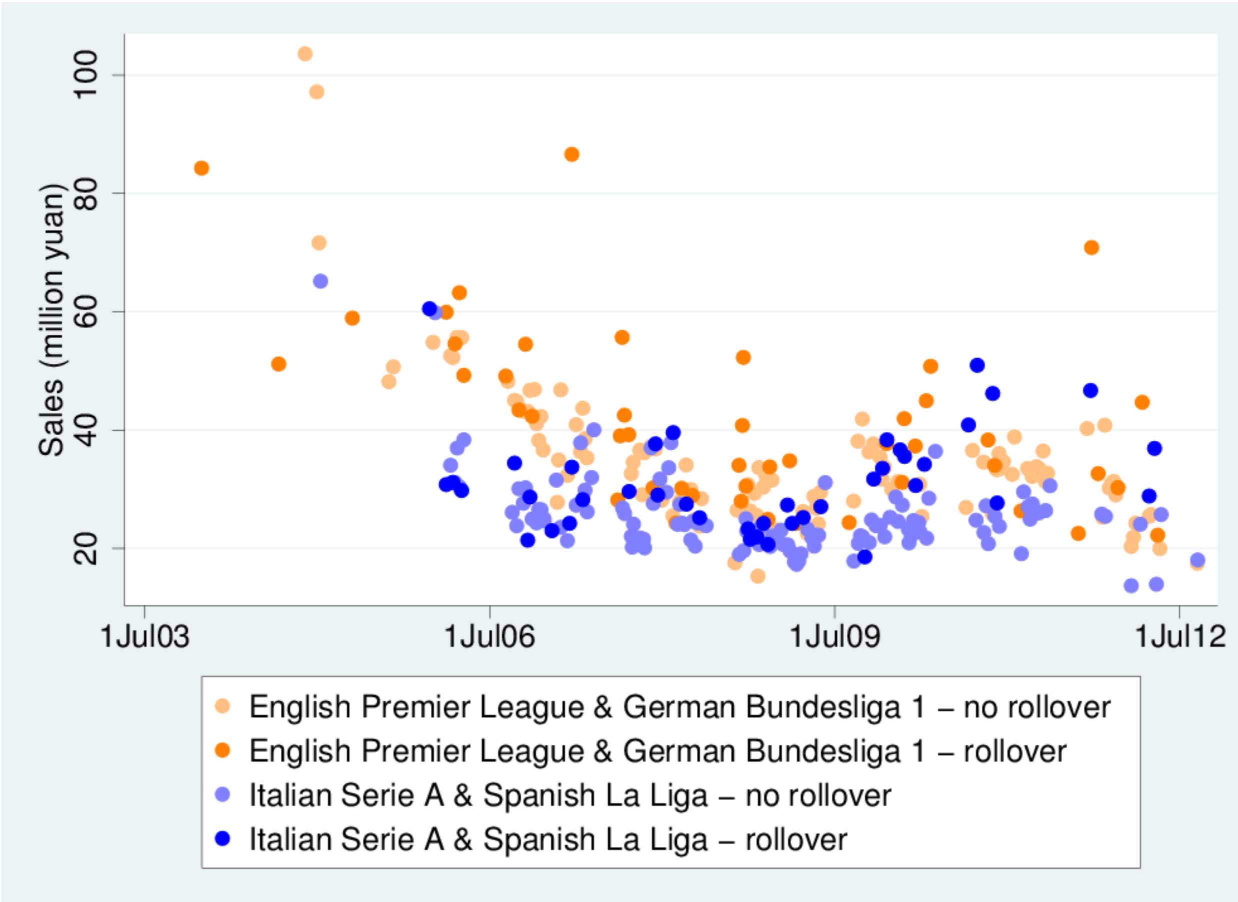

Figure 4-3. Impact of ticket composition and rollover on demand: Using four most popular leagues as an example

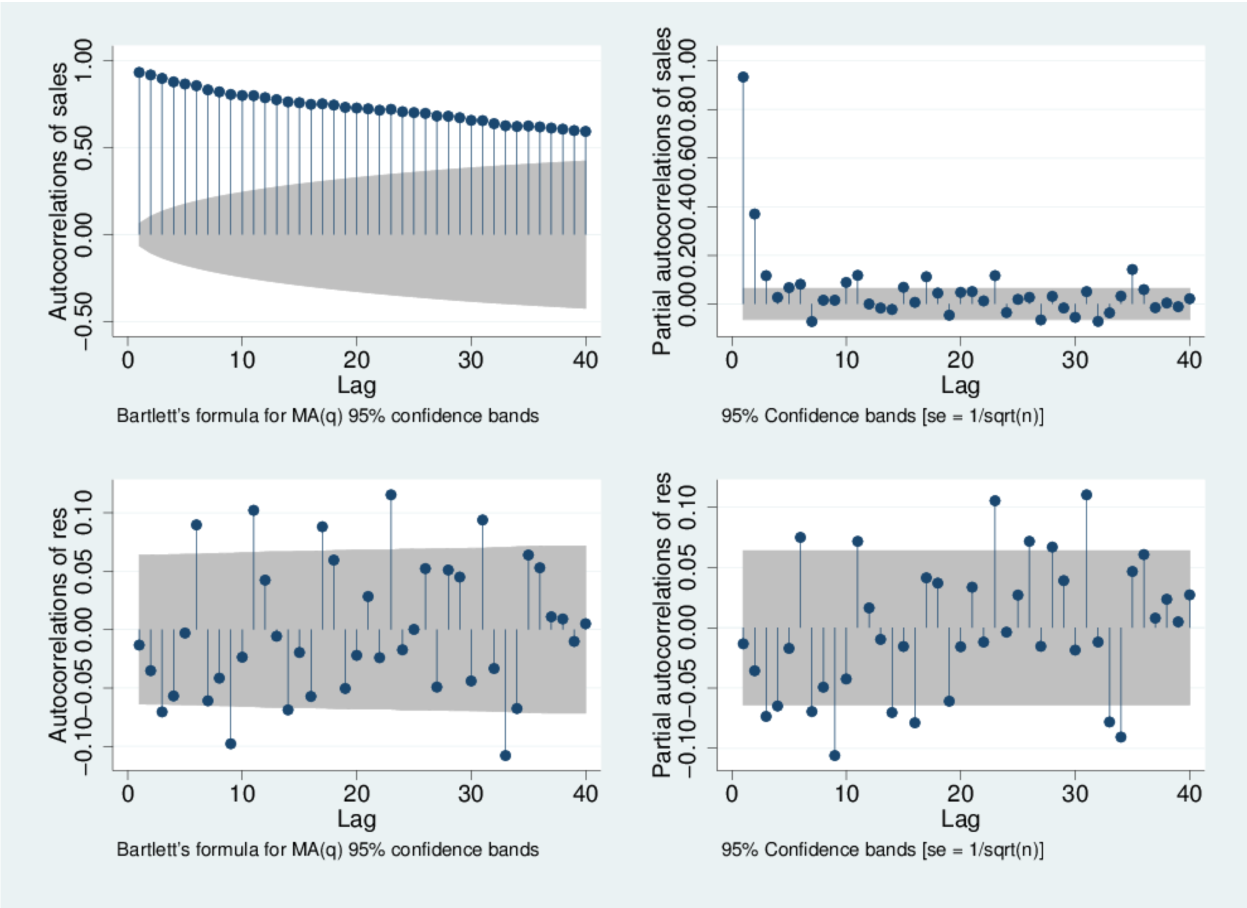

Figure 4-4. ACF-PACF of sales and residuals of its AR(2) model

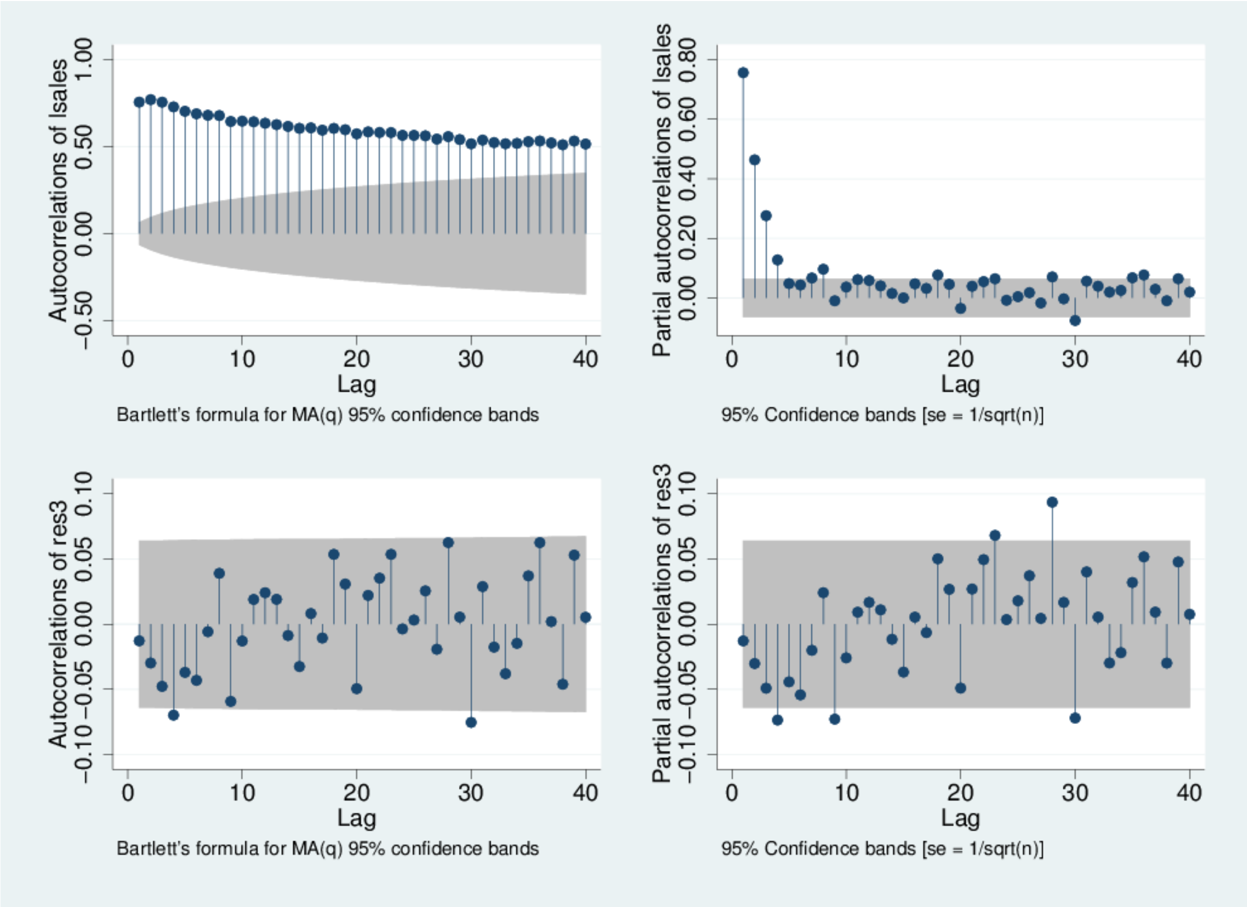

Figure 4-5. ACF-PACF of log(Sales) and residuals of its AR(4) Model

Table 4-2. Results of time series regressions

	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS	(7) 2SLS	(8) LIML
L.lsales	0.131**	0.0857**	0.0800**	0.240**	0.254**	0.204**	0.205**	0.206**
	(0.0261)	(0.0187)	(0.0177)	(0.0407)	(0.0346)	(0.0308)	(0.0309)	(0.0315)
L2.lsales	0.159**	0.0693**	0.0615**	0.327**	0.260**	0.196**	0.200**	0.203**
	(0.0237)	(0.0167)	(0.0169)	(0.0371)	(0.0326)	(0.0318)	(0.0318)	(0.0335)
L3.lsales	0.141**	0.0808**	0.0650**	0.262**	0.201**	0.128**	0.131**	0.134**
	(0.0280)	(0.0196)	(0.0193)	(0.0428)	(0.0371)	(0.0342)	(0.0334)	(0.0344)
L4.lsales	0.0449*	0.0369**	0.0252	0.149**	0.128**	0.0781**	0.0837**	0.0895**
	(0.0258)	(0.0187)	(0.0183)	(0.0447)	(0.0367)	(0.0334)	(0.0326)	(0.0345)
Log(EP)	0.162**	0.277**	0.196**	-0.377**	-0.425**	-0.564**	-0.780**	-1.009**
	(0.0698)	(0.0570)	(0.0615)	(0.0865)	(0.0786)	(0.0835)	(0.0745)	(0.390)
Log(TJ)	0.475**	0.613**	0.590**		-	-	-	-
	(0.0205)	(0.0209)	(0.0211)					
EPL&GB		0.132**	0.168**		0.379**	0.484**	0.490**	0.497**
		(0.0246)	(0.0251)		(0.0417)	(0.0406)	(0.0404)	(0.0427)
ISA&SLL		-0.00977	0.0230		0.0380	0.146**	0.148**	0.149**
		(0.0251)	(0.0252)		(0.0425)	(0.0419)	(0.0416)	(0.0428)
MAJOR4		0.147**	0.162**		0.420**	0.484**	0.500**	0.516**
		(0.0274)	(0.0279)		(0.0488)	(0.0458)	(0.0452)	(0.0552)
1TIER		0.0437	0.0347		0.132**	0.0899*	0.0972*	0.105*
		(0.0286)	(0.0308)		(0.0508)	(0.0535)	(0.0536)	(0.0563)
2TIER		-0.0887*	-0.0979*		-0.187*	-0.216**	-0.205**	-0.194**
		(0.0491)	(0.0511)		(0.103)	(0.0966)	(0.0911)	(0.0891)
3TIER		-0.0916**	-0.111**		-0.306**	-0.325**	-0.319**	-0.312**
		(0.0351)	(0.0348)		(0.0607)	(0.0570)	(0.0555)	(0.0587)
PDC		-0.134**	-0.126**		0.00646	0.0159**	0.0155**	0.0150**
		(0.00688)	(0.00694)		(0.00733)	(0.00694)	(0.00694)	(0.00717)
PDCSQ		0.0161**	0.0156**		0.000885	0.000555	0.000919	0.00130
		(0.00123)	(0.00122)		(0.00168)	(0.00160)	(0.00158)	(0.00172)

Table 4-2. Continued

	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS	(7) 2SLS	(8) LIML
D2D			-0.0578**			-0.162**	-0.161**	-0.160**
			(0.0226)			(0.0399)	(0.0397)	(0.0404)
DPRO			-0.0911**			0.220**	0.197**	0.173**
			(0.0412)			(0.0672)	(0.0713)	(0.0880)
D3P			0.0812**			0.143**	0.197**	0.254**
			(0.0287)			(0.0544)	(0.0560)	(0.110)
D14M			-0.163**			-0.562**	-0.582**	-0.604**
			(0.0376)			(0.0785)	(0.0808)	(0.0870)
NUM			-0.00498			-0.0425**	-0.0439**	-0.0454**
			(0.0106)			(0.0180)	(0.0178)	(0.0182)
Constant	0.393**	0.707**	1.086**	0.223**	0.543**	1.959**	2.008**	2.060**
	(0.0409)	(0.0436)	(0.102)	(0.0624)	(0.0725)	(0.209)	(0.212)	(0.226)
N	938	938	938	941	938	938	938	938
F	1278.1	713.5	574.8	673.7	309.6	287.4	270.8	247.1
R^2	0.862	0.929	0.932	0.708	0.786	0.818	0.815	0.806
BIC	435.6	-130.1	-138.8	1130.0	892.4	776.1	790.6	835.8

Note:
(a) Heteroskedasticity-robust standard errors in parentheses.
(b) * p<0.10, ** p<0.05.

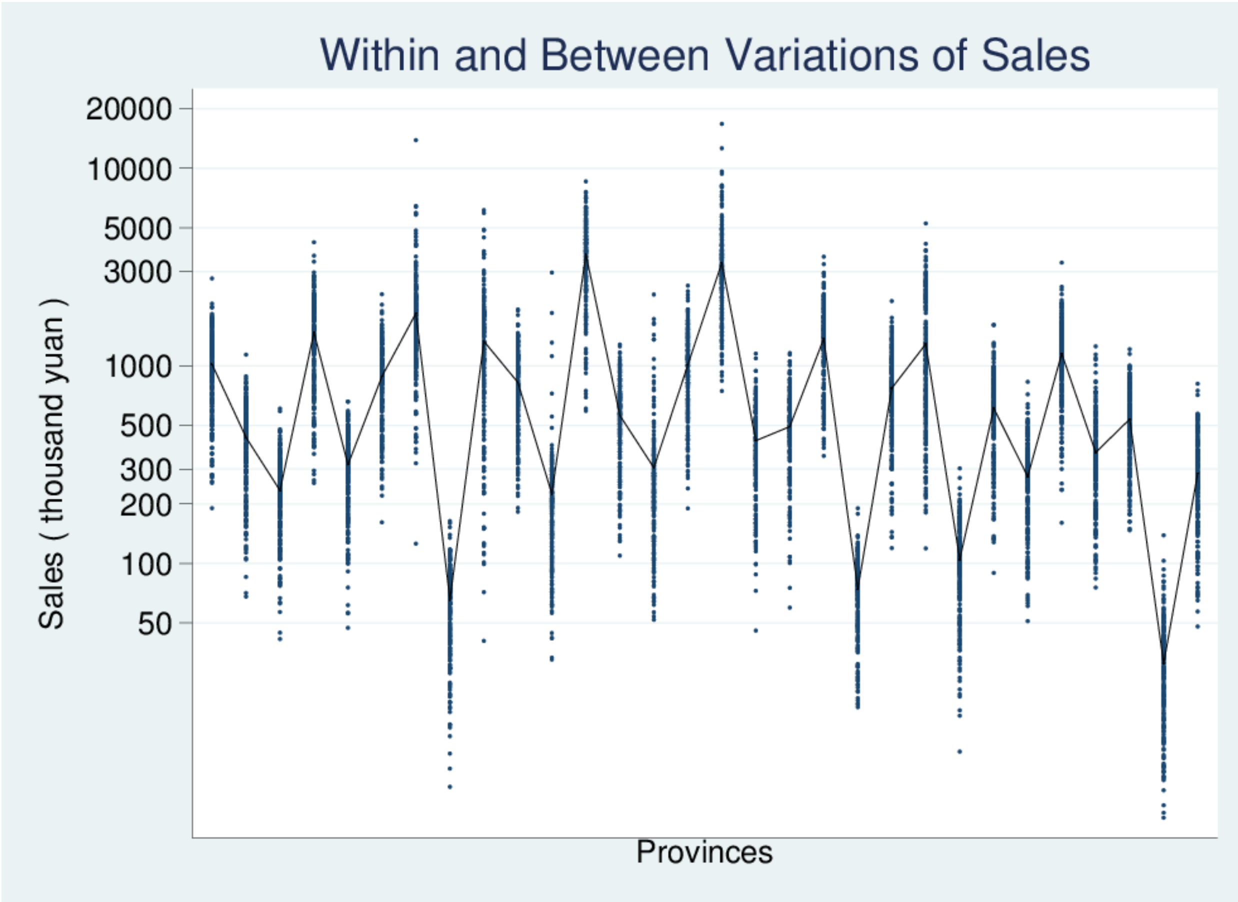

Figure 4-6. Within and between variations in panel data

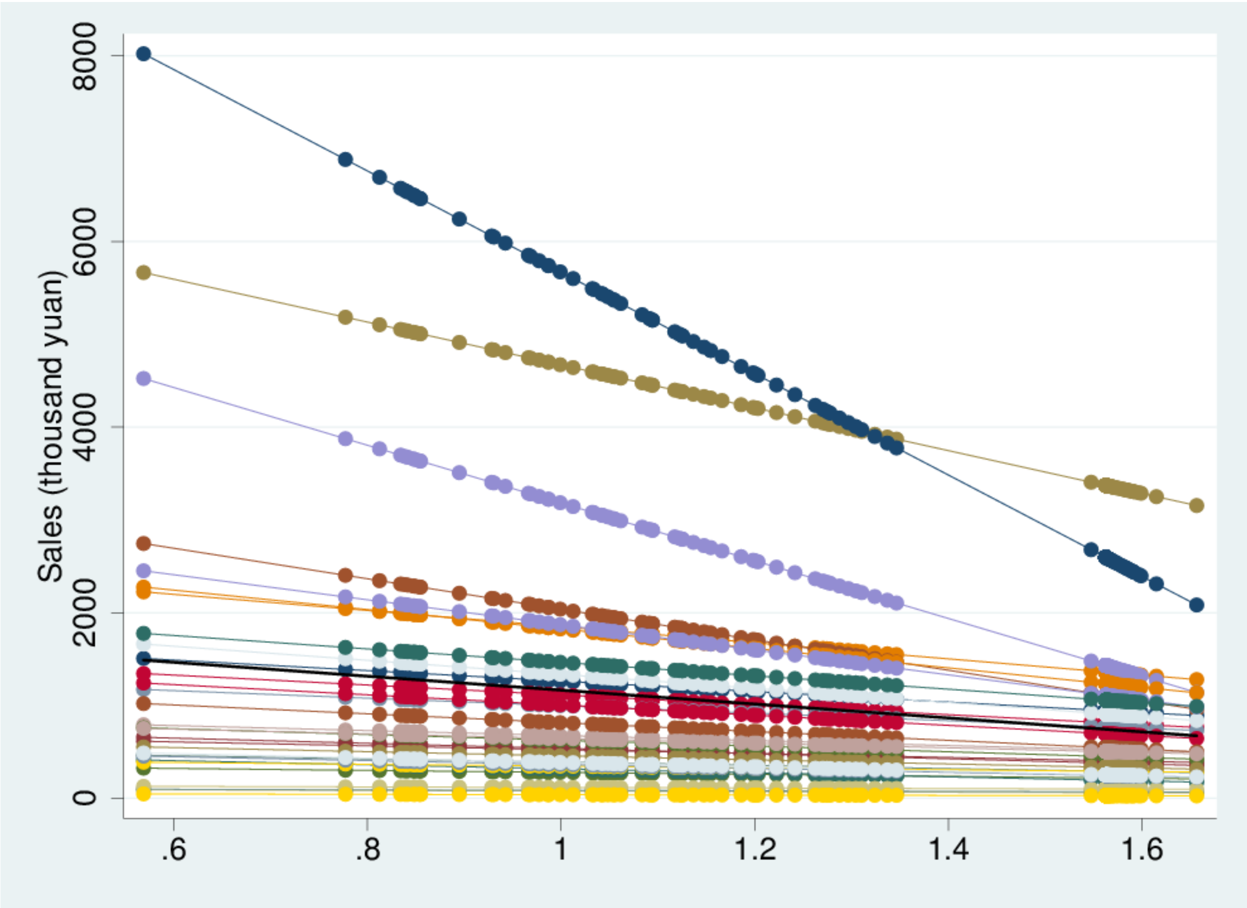

Figure 4-7. Separate simple regressions of 30 provinces: sales on effective price

Table 4-3. Descriptive statistics for the panel data analysis

Variables	Category	*Mean*	*SD*	*Min*	*Max*	*N*
Log(sales)	overall	6.10	1.23	1.64	9.73	6330
	between		1.12	3.27	8.09	30
	within		0.56	2.92	8.92	211
Time-variant Individual-invariant Variables						
EP	within	0.34	0.20	-0.56	0.50	211
EPL&GB	within	0.14	0.34	0	1	211
ISA&SLL	within	0.08	0.27	0	1	211
1TIER	within	0.08	0.27	0	1	211
MAJOR4	within	0.25	0.43	0	1	211
2TIER	within	0.06	0.23	0	1	211
3TIER	within	0.18	0.39	0	1	211
PDC	within	1.72	2.04	-3.80	7.27	211
PDCSQ	within	7.14	9.03	0	52.80	211
D2D	within	0.09	0.29	0	1	211
NUM	within	3.00	1.09	1	5	211
Time-invariant Individual-variant Variables						
Log(POP)	between	3.48	0.87	1.10	4.65	30
TDR	between	34.46	6.91	20.95	51.04	30
HER	between	9.79	5.24	5.29	31.50	30
ILR	between	4.24	2.26	1.70	10.23	30
SPORT	between	-0.02	0.99	-1.01	2.10	30
Log(INCOME)	between	9.26	0.43	8.59	10.41	30
Log(NTER)	between	7.91	0.87	5.37	9.39	30

Table 4-4. Results of panel data regressions

	Pooled Models			Fixed Effects Models				Random Effects Models		
	PM1	PM2	PM3	FE1	FE2	FE3	FE4	RE1	RE2	RE3
L.lsales			0.37**		0.20**		0.13	0.37**	0.29**	0.30**
			(0.01)		(0.01)		(0.16)	(0.01)	(0.01)	(0.01)
L2.lsales			0.19**		0.06**		0.00	0.18**	0.16**	0.16**
			(0.01)		(0.01)		(0.19)	(0.01)	(0.01)	(0.01)
L3.lsales			0.20**		0.11**		0.05	0.13**	0.23**	0.24**
			(0.01)		(0.01)		(0.08)	(0.01)	(0.01)	(0.01)
L4.lsales			0.18**		0.11**		0.07	0.12**	0.22**	0.22**
			(0.01)		(0.01)		(0.08)	(0.01)	(0.01)	(0.01)
log(EP)	-1.07**	-1.07**	-0.94**	-1.07**	-1.09**	-1.07**	-1.09**	-1.09**	-1.23**	-0.95**
	(0.05)	(0.14)	(0.10)	(0.03)	(0.02)	(0.03)	(0.32)	(0.12)	(0.03)	(0.13)
EPL&GB	0.46**	0.46**	0.34**	0.46**	0.44**	0.46**	0.46**	0.44**	0.39**	0.38**
	(0.01)	(0.06)	(0.06)	(0.02)	(0.02)	(0.02)	(0.16)	(0.07)	(0.02)	(0.02)
ISA&SLL	0.30**	0.30**	-0.04	0.30**	0.17**	0.30**	0.21**	0.10	0.07**	0.07**
	(0.01)	(0.06)	(0.06)	(0.02)	(0.02)	(0.02)	(0.09)	(0.08)	(0.02)	(0.02)
MAJOR4	0.34**	0.34**	0.16**	0.34**	0.30**	0.34**	0.32	0.27**	0.25**	0.25**
	(0.02)	(0.07)	(0.06)	(0.02)	(0.02)	(0.02)	(0.20)	(0.08)	(0.02)	(0.02)
1TIER	0.36**	0.36**	0.21*	0.36**	0.28**	0.36**	0.32	0.21	0.22**	0.20**
	(0.02)	(0.14)	(0.11)	(0.03)	(0.03)	(0.03)	(0.40)	(0.13)	(0.03)	(0.03)
2TIER	-0.15**	-0.15	-0.24**	-0.15**	-0.21**	-0.15**	-0.18	-0.25**	-0.26**	-0.26**
	(0.02)	(0.10)	(0.09)	(0.02)	(0.02)	(0.02)	(0.52)	(0.11)	(0.02)	(0.02)
3TIER	-0.72**	-0.72**	-0.50**	-0.72**	-0.68**	-0.72**	-0.68**	-0.66**	-0.66**	-0.64**
	(0.03)	(0.09)	(0.07)	(0.02)	(0.02)	(0.02)	(0.15)	(0.08)	(0.02)	(0.02)
PDC	0.03**	0.03*	0.02*	0.03**	0.03**	0.03**	0.03**	0.03*	0.03**	0.03**
	(0.00)	(0.02)	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)	(0.02)	(0.00)	(0.00)
PDCSQ	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
D2D	-0.24**	-0.24**	-0.17**	-0.24**	-0.24**	-0.24**	-0.21	-0.24**	-0.25**	-0.25**
	(0.01)	(0.08)	(0.07)	(0.02)	(0.02)	(0.02)	(0.64)	(0.08)	(0.02)	(0.02)

Table 4-4. Continued

	Pooled Models			Fixed Effects Models				Random Effects Models		
	PM1	PM2	PM3	FE1	FE2	FE3	FE4	RE1	RE2	RE3
NUM	-0.07**	-0.07**	-0.05**	-0.07**	-0.08**	-0.07**	-0.07	-0.08**	-0.08**	-0.09**
	(0.00)	(0.03)	(0.02)	(0.01)	(0.01)	(0.01)	(0.09)	(0.03)	(0.01)	(0.01)
log(POP)	0.22	0.22**	0.01**			0.22		0.04	0.02	0.02
	(0.39)	(0.01)	(0.01)			(0.45)		(0.09)	(0.02)	(0.02)
TDR	0.11**	0.11**	0.01**			0.11**		0.02**	0.01**	0.01**
	(0.04)	(0.00)	(0.00)			(0.04)		(0.01)	(0.00)	(0.00)
HER	0.02	0.02**	0.00			0.02		0.00	0.00	0.00
	(0.04)	(0.00)	(0.00)			(0.05)		(0.01)	(0.00)	(0.00)
ILR	-0.00	-0.00	-0.00			-0.00		-0.00	-0.00	-0.00
	(0.08)	(0.00)	(0.00)			(0.08)		(0.02)	(0.00)	(0.00)
SPORT	0.03	0.03**	0.00			0.03		0.01	0.00	0.00
	(0.22)	(0.01)	(0.00)			(0.27)		(0.05)	(0.01)	(0.01)
log(INCOME)	2.03**	2.03**	0.11**			2.03**		0.39**	0.19**	0.19**
	(0.94)	(0.03)	(0.02)			(0.97)		(0.19)	(0.04)	(0.04)
log(NTER)	0.32	0.32**	0.01**			0.32		0.06	0.03*	0.03*
	(0.32)	(0.02)	(0.01)			(0.45)		(0.09)	(0.02)	(0.02)
Constant	-19.56**	-19.56**	-0.65**	6.55**	3.70**	-19.56**	4.99*	-3.31*	-1.22**	-1.31**
	(9.56)	(0.36)	(0.20)	(0.02)	(0.08)	(9.18)	(2.59)	(1.78)	(0.35)	(0.35)

Notes:
(a) PM1- OLS with cluster-robust standard error; PM2-Pooled OLS with serial correlation in the error and correlation over provinces (i.e., Driscoll-Kraay standard errors): PM3-Pooled Feasible Generalized Least Squares including 4 lags of log(sales)(PFGLS); FE1-Least Squares Dummy Variables (static); FE2-Least Squares Dummy Variables (including 4 lags); FE3-Hausman-Taylor method; FE4-Arellano-Bond method; RE1-Two-way Random-effects models; RE2-One-way random-effect model using rollover as instrument; RE3-One-way random-effect model using prize cap as instrument.
(b) Heteroskedasticity-robust standard errors in parentheses.
(c) * $p<0.10$, ** $p<0.05$.

CHAPTER 7
DISCUSSION

Despite that sports lottery gambling has become a prevalent economic and recreational activity, it remains an under-researched area in sports management literature. Having recourse to Expected Utility Theory and its generalizations, an econometric model of demand for sports lottery gambling was constructed. The model assumes an experiential utility associated with lottery gambling, and proposes that rational consumers are mainly motivated by three clusters of variables: product attributes, consumer demographics, and marketing variables. The model is empirically examined by using a set of draw-to-draw sales data of the *Shengfu* game, the most representative sports lottery in China. Through time-series and panel data analyses, this study has the following major findings: (a) sports gambling has consumption value, as evidenced by that the ticket composition has considerable impact on the demand; (b) consumers are sensitive to the implicit cost of a buying lottery ticket (i.e., effective price), where the estimated price elasticity is around -1; (c) at least in the context of Chinese sports betting market, the province with higher income level had higher demand for sports lottery, contradicting the regressivity property of traditional lottery games. The estimated income elasticity is around 0.4; (d) consistent with the research findings of previous studies, population segments with higher financial and social burdens tends to buy more lottery tickets; (e) marketing variables and structural arrangements of the game were found have significant impact on consumer demand of sports lottery tickets; (f) consumers showed signs of learning from betting experience and increasing the odds of winning as evidenced by an ever increasing median probability of winning first and second prizes; and (g) population, education level, sport development level, and venue accessibility were found not significantly related to the demand of sports lottery tickets.

Theoretical Contributions

Sports Lottery as Consumption

Through time series and panel data regressions, this study revealed that the ticket composition has considerable impact on the demand. As mentioned, six dummy variables (i.e., EPL&GB, ISA&SLL, MAJOR4, 1TIER, 2TIER, and 3TIER) were included in the models. Comparing with the baseline, a mixture of different levels of leagues and tournaments, EPL&GB, ISA&SLL, MAJOR4, and 1TIER had significant positive impact on the demand, whereas 2TIER and 3TIER had significant negative impact on the demand. The magnitude of impact is non-trivial. Since the inception of the *Shengfu* game, the draws consisting of EPL&GB were associated with about 60% more sales; whereas the draws consisting of 3TIER were associated with about 30% less sales. The finding of this study is consistent with García and Rodríguez (2007), who found that in Spanish La Quiniela game, draws with the absence of First Division matches were associated with a 53% reduction in sales. They suggested that the finding justifies why clubs' association receives 10% of the revenue generated by La Quiniela and are asking to increase this percentage. But, they did not further explain why this phenomenon would occur from a theoretical perspective.

If sports lottery is merely gambling, the consumption values of spectatorship of a given match should not have direct systematic impact on the demand for its gambling product. After all, according to existing lottery gambling theories, it is the probability of winning, size of jackpot pool (amount of prizes), prize structure, and the potential dilution of the prizes that affect the expected value of a lottery product (Cook &

Clotfelter, 1993; Garrett & Sobel, 2004; Shapira & Venezia, 1992). Ticket composition is indeed systematically associated with the objective probability of winning as measured by prediction difficulty coefficients. A MANOVA analysis revealed that there were significant differences with RAT1 and RAT2 among different ticket composition groups (Table 5-1). Comparing with the baseline, the probabilities of winning any prize when draws are composed of EPL&GB, ISA&SLL, MAJOR4, and 3TIER are lower. In contrast, the probability of winning any prize when draws are composed of 1TIER and 2TIER are higher. This also justifies the inclusion of PDC. Although the objective probability of winning, and accordingly, the potential dilution of the prizes, indeed depend on the composition of the matches, the traditional theory predicts no additional impact of ticket composition on the demand after controlling the indirect routes.

This study suggests that sports lottery gambling may be considered as a consumption practice. As such, players may derive additional utility from gambling on different matches. There are, however, two theoretical accounts. First, the market is composed of homogenous gamblers who consume "gambling", and the additional utility resides inside of gambling itself as Conlisk (1993) proposed. For instance, betting on certain leagues or tournaments can generate more excitement or thrill, which can in turn translate into greater gambling utility, then gamblers may increase their consumption on those draws because they gain more utility. Why then is betting on EPL&GB more exciting than betting on ISA&SLL? Do these two combinations differ on some aspects of their gambling properties, such as confidence of prediction, knowledge, prize pool, and objective winning probability? For instance, if consumers can foresee larger prize pool is often associated with EPL&GB, or those draws are easier to predict, then they may buy more tickets in those draws. This flies in the face of the fact that both the winning probabilities and size of prizes appear to be very close. Given that all four leagues have a prominent presence in China for a long time and there is extensive media coverage about all these four leagues, it is unlikely that these two combinations differ significantly in terms of their gambling properties.

Second, the additional demand may arise from an additional segment of players who view sports betting as a derivative of spectator sports and consume sports betting. Can the additional demand associated with EPL&GB be that they collectively have a larger fan base in China? Draws composed of EPL&GB attract additional sports fans to the betting market. For professional gamblers, they gamble anyway. However, sports fans may only gamble on their favorite leagues. Then the additional demand actually arises from sports fans consuming sports. Given that ticket composition does have direct systematic impact on the demand, we subscribe to the second explanation. The market is composed of at least two heterogeneous segments: one is gamblers and the other is sports consumers. Sports consumers take part in sports betting as consuming a derivative product of spectator sports.

Rationality in Sports Gambling

Besides the consumption value of sports betting, players also exhibit some rationality in sports betting as they are rather sensitive to the implicit cost of buying a lottery ticket. The estimated effective price elasticity is around -1 by using time series and panel data analysis, which implies that 1% increase in effective price will lead to 1% decrease in sales. Although several studies have estimated effective price elasticities of different lottery products in the United States, United Kingdom, and Spain, the results are not directly comparable because this study adopts a different specification of effective price and the lottery products differ in nature. Because effective price essentially converges to the take-out rate when the sales are large, researchers often interpret effective price elasticity as if the elasticity of sales with regard to take-out rate and conclude a -1 elasticity implies profit maximization. However, because effective price is not only a function of take-out rate but also a function of prediction difficulty coefficient, it is not appropriate to interpret it as actual price but merely an indication of players' responsiveness to the implicit cost of a lottery ticket.

Additionally, the prediction difficulty coefficient is positively related to sales, indicating that draws that are perceived as easier are associated with larger sales. Furthermore, the quadratic term of prediction easiness coefficient is not found significantly related to sales, suggesting that the increasing relationship between prediction easiness and sales is monotonic. In a similar token, the number of leagues included in a draw is negatively related to sales, indicating that having more leagues in a draw is associated with smaller sales. This is because having more leagues in a draw potentially increases the difficulty of betting as players may need to allocate more time to follow the matches or require broader knowledge about soccer betting. Although an easy game increases the probability of prize sharing, it simultaneously increases the prize pool. With sufficiently large sales, the effective price approximates the take-out rate. Considering sports gambling as a consumption practice, the rationality of buying sports lotteries can be justified. Furthermore, the monotonically increasing relationship between demand and prediction easiness further supports this notion.

Impact of Social Demographics

Through panel data regressions, this study revealed that some social demographics have significant impact on the demand for sports lottery. First, in the context of the Chinese sports betting market, the provinces with higher income levels had a higher demand for sports lottery, contradicting the regressivity property of traditional lottery games found in many studies (Clotfelter, 1979; Combs et al., 2008; Miyazaki et al., 1998; Price & Novak, 1999; Suits, 1977a). Although the estimations of income elasticity from the static and dynamic models differ drastically in terms of its magnitude, the sign remains positive. The income elasticity of *Shengfu* lotteries is estimated around 2 in the static models, suggesting the demand is highly income elastic and can even be viewed as a “luxury” good for Chinese consumers. In the dynamic models, however, the income elasticity of *Shengfu* lottery is estimated around 0.4. This suggests that given the initial state of demand, the players are less responsive with regards to the change of income levels.

Second, the population composition was found to be related to the demand for sports lottery. Using TDR as a measure of financial and social burdens, this study found that TDR is positively related to demand, which is consistent with previous research that used transfer payment as a measure of financial and social burdens (Weinbach & Paul, 2008). Within the context of China, intergenerational-support family-based care has been at the core of Chinese families. A majority of the elderly live with one of their children and rely on their support. With the skyrocketing of real estate prices and living costs in China, many families encounter high financial and social burdens. Lottery has long been regarded as the only vehicle for them to buy hope. The finding in this study seems to be reflective on this social reality.

Impact of Marketing and Structural Changes of the Game

Over the years, the sports lottery administration has modified the structure of the *Shengfu* game in several aspects, accompanied with infrequent jackpot promotional activities or simultaneously declaring two draws on the same day. For instance, during August 2003 to August 2004, there were three prizes instead of the current two prizes; before September 2004, there were 13 matches included in a draw instead of 14 matches. The current study showed that since the adoption of 14 games, the demand for the *Shengfu* game has decreased. However, this significant negative relationship is not necessarily causal. It can be coincidental, simply due to the life cycle of the game. Nevertheless, changing the game structure has a potential impact on demand for the following possible reasons. First, increasing the number of matches in a draw means more constraints on the administrator's license of picking matches. This study has shown the popular leagues can attract more players to buy lottery tickets. Therefore, choosing only top teams will maximize consumer surplus and revenue. However, compared to 13 matches, having 14 matches in a draw results in a greater probability of picking less popular matches. Because, less popular matches have negative impact on sales, the adoption of 14 matches, therefore, has a potential negative impact on demand. Second, for consumers, predicting 14 matches is apparently more difficult. If the finding that people like easy game holds, then the adoption of 14 matches has a second negative impact on demand.

Jackpot promotion is positively associated with sales, which is rather intuitive. And this positive relationship is unlikely coincidental as the jackpot promotion was done in an irregular fashion. Draws that had a jackpot promotion had a higher pay-off compared to those without a promotion. As demonstrated that players are indeed sensitive to price, jackpot promotion can effectively increase sales. This marketing strategy could be especially useful when administrators can foresee a decrease for certain draws that are composed of unpopular matches.

Having three prizes is positively associated with sales. Although this significant positive relationship is not necessarily causal, prize structure has the potential to impact demand. By having a third prize, players have a greater probability of winning a prize. From gambling as learned practice perspective, winning will reinforce players' gambling behavior and thus stimulates the demand. It is common phenomenon in gambling that when a player wins a small prize, they wish to win a larger one more earnestly because winning a prize was no longer merely a dream. It became a reality instead.

Simultaneously selling two draws in the same period of time will apparently reduce the sales of each draw. But collectively, simultaneously selling two draws can be more profitable for the sports lottery administrators. Although two draws were sold simultaneously and the prize would be declared on the same day, the two draws had an order. For instance, if draw 2012001 and 2012002 were declared same day, the prize pool of 2012001 is composed of a possible rollover from its previous draw(s). This information is known to players who buy 2012001. However, because the prize pool of 2012002 also depends on 2012001, players who buy 2012002 actually face more uncertainty about the prize pool. Comparing draws with uncertainty to draws with rollover information revealed that the former sells significantly less (Table 5-2). This suggests that players do not like uncertainty in the prize pool, which is consistent with the uncertainty aversion (i.e., ambiguity aversion) in decision theory. Ambiguity aversion phenomenon found in this study also suggests the players hold rational attitude towards the probability of future outcomes, both unfavorable and favorable.

Consumer Learning or Consumer Attrition

Despite the fact that lottery administration has made the *Shengfu* game more difficult by increasing the number of the matches to 14, there is an ever increasing trend of median probability of winning prizes. This suggests that overall the players are doing a better job in predicting the results of soccer games. There is the possibility that the skills of players does improve as a result of more experience and more information which is now accessible online.

However, this phenomenon can also be explained by consumer attrition. It is possible that the market lost the players who never won or had less skill in betting, and only those more sophisticated players are left in the market, thus, increasing the median chance of winning. Or, it can be the result of both consumer learning and consumer attrition.

Dynamic Nature of Sports Gambling Behavior

It has been suggested that the consumption of lottery products is dynamic in nature due to myopic addiction (Farrell et al., 1999), inertia (Beenstock & Haitovsky, 2001), or social learning (Rogers, 1998). Despite different behavioral assumptions made under these three theoretical accounts, they are not mutually exclusive and have the same prediction that consumption in the previous period(s) has a positive and significant effect on consumption in the current period.

This study used a dynamic model with four lagged dependent variables to explain the demand for sports lottery. A four lag period is about 2 to 4 weeks. Whereas this study does not preclude the plausibility of addiction, inertia or learning, an alternative mechanism is suggested. It is conjectured that information contained in the previous draws has an impact on the betting behavior for the current draw. Forecasting the expected return of a draw often involves predicting the odds of winning, the prize pool, and the possibility of prize sharing, and correct forecasting is not an easy task for players. It is plausible that the players will consider the results of previous draws in making their betting decision. Because of recent publicity about the prize pool and the odds of winning may be more salient in their minds, they may use this information to guide their forecasting. Additionally, although matches were selected from various leagues and differ draw by draw, many matches have a natural progression in a season. Typically, a regular season is followed by a play-off. As a consequence, the demand for sports lottery shows a dynamic pattern.

Managerial Implications

Despite the theoretical implications of players' betting behavior and demand for sports lottery, this study also proffers some managerial implications for sports lottery administrators. First, the consumption value of sports lottery games needs to be better appreciated. The notion that nonmonetary activities associated with sports lottery gaming has consumption value has considerable implications in terms of designing lottery products and delivering value to its consumers. For instance, if simply dreaming of winning a grand prize can generate utility, then players would probably prefer a week-long dream rather than a shorter one. If talking about betting on a team can enhance their identification with a team, then they would probably prefer a larger audience. Or if bragging about winning can show off their expertise in their own circles, then making prizes more accessible would probably boost the morale of players. In a nutshell, under the theory of consumption, players should be treated and managed as consumers; and their behavior needs to be understood in order to develop value-added programs for them.

Second, players are rational in terms of their responsiveness to the cost of the game. The empirical results suggests that the administrators have already done a fairly good job in maximizing profits. The panel regression analysis also suggested there were significant differences among the 30 provinces. The effective price elasticity ranged from -0.7 to -1.8. Currently, marketing activities, such as jackpot promotion, are often conducted on the national level with very limited customizations to the local markets. It is advisable that marketing strategies to be developed to meet local needs. For instance, in a marketplace where players are more sensitive to the effective prices, additional jackpot promotions may be conducted to bring down the effective price of the game in that market; in a marketplace where players are less sensitive to the effective prices, the take-out rate actually may be increased in order to be more profitable. In order to keep the whole market unified, a higher take-out rate can be unanimously levied, but with differentiated jackpot promotions taking place in regional levels.

Third, time series analysis revealed that the market for *Shengfu* game was not evolving. Most lotteries suffer from 'fatigue'. Once the initial excitement of the launch wears off, and revenues tend to stagnate or even decline (Creigh-Tyte & Farrell 2003). The good news for *Shengfu* game was that fatigue did not appear to set in or the administrators successfully overcame the market fatigue through product innovation. The bad news, however, was that the game never truly took off. Furthermore, empirical data suggests a positive effect of jackpot promotion on demand. Unfortunately, this effective marketing tool is seldom exercised by the administrators. Further, this study suggested that structural features, such as number of matches include in a game and the number of prizes, were associated with demand. Lottery administrators may experiment with different game features in order to design a better product for players.

Limitations and Future Directions

Although this dissertation has provided valuable insight into understanding betting behavior and the determinants for sports lottery, there are some limitations that should be considered for future research. This first limitation is related to the fact that this study only focused on one sports lottery product, namely the *Shengfu* game, in the context of China. Despite its theoretical contribution to the gambling and sports management literature, the generalizability of some findings from this study might be limited. Therefore, the theory of sports gambling as consumption practice should be tested repeatedly with empirical data obtained from other types of sports lottery products both in China and other markets for future studies.

Second, this study used macro-level (i.e., provincial level) data to examine the arrogate market demand. Although it identified several major factors influencing the demand for sports lottery in China, it did not thoroughly take individual preference and decision making into consideration. Some findings are merely suggestive, for instance, the positive relationship between prediction easiness and demand, and the positive elasticity of income. For future research, individual level data would be more desirable as they contain richer information to examine the demand function in a more refined fashion. A third limitation relates to the data source. The data were obtained through public records or officially released government documents. However, some of the data released were rather coarse and might also be inaccurate as China has been notoriously known for its suspect statistics. Finally, not all determinants would be included in the empirical regression model, due to either limited variability in the data (e.g., gender and ethnicity) or unavailability of the data (e.g., religion and cross-border shopping behavior).

The current research has identified several interesting avenues for future research. These include, but are not limited to, investigation of the following questions: How to measure consumption value of sports gambling? What are the interrelationships between sports betting and sports spectatorship? How do players make decisions and how do they improve their betting skills? What are the implications of consumer learning on sports lottery administration? How do players respond to marketing activities, such as jackpot promotion, outlet expansion, and lottery advertising? Furthermore, there are many other types of sports betting products, such as office pools and parlay betting, that warrants future scholarly efforts.

Conclusion

This study examined the demand for sports lottery based on the assumption that players are rational and sports gambling has consumption value. Our raw data suggests that there is quite a considerable consumption value of sports gambling and that this is essentially induced by the different matches included in the game. The effective price elasticity is identified through changes in the expected value of holding a ticket, variations in which are driven by rollovers and consumer learning. This study found that the implied elasticity is estimated around -1, suggesting the realization of revenue maximization for regulators. Although it is not conclusive, there is evidence to suggest that sports lottery is progressive, i.e., that the rich tend to buy more sports lottery than the poor. Consistent with the notion that buying lottery is to buy hope, this study found a positive relationship between demand and financial burden as measured by the Total

Dependence Rate and demand. Jackpot promotion and structural arrangements of the game were found have significant impact on the demand.

Table 5-1. Prediction difficulty coefficients by ticket compositions

	Frequency	Percentage	RAT1	RAT2
EPL&GB	173	18.31	1.96	1.50
ISA&SLL	182	19.26	2.03	1.45
MAJOR4	204	21.59	1.42	1.31
1TIER	73	7.72	2.83	2.81
2TIER	52	5.50	2.9	2.13
3TIER	105	11.11	2.21	1.23
Baseline	156	16.51	2.41	1.82

Note: RAT1 = log(observed number of first prize winners / theoretical number based on null model); RAT2 = log(observed number of second prize winners / theoretical number based on null model).

Table 5-2. Sales comparison between two simultaneous draws

Group	n	Mean	SD	T	df	p
Draw_1	72	39.36	21.55	5.30	104.8	<.001
Draw_2	73	24.30	10.91			

Note: df is Satterthwaite's degrees of freedom which takes into account that the variances are assumed to be unequal. It is a more conservative approach than using the traditional degrees of freedom.

APPENDIX
SUPPORTING INFORMATION FOR CHAPTER 3

China CSLAC Lottery *Shengfu* Game Sample Ticket (14 Matches)


足球彩票<胜负玩法>
90018111910151200022 VGggtX 13755652
销售点:19101 05018期 2005/05/02开奖
合计:256元 2005/04/30 15:43:04
复式票

佛罗伦	国米	尤文	莱切	梅西纳	帕尔玛	罗马	乌迪内	博尔顿	查尔顿	富勒姆	利物浦	纽卡斯	热刺
.	3	3	.	.	3	3	3	3	.	3	.	3	3
.	.	1	1	.	1	.	.	.	.	1	.	.	1
0	0	.	.	0	.	.	.	0	0	.	0	0	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.

电话查询:962858短信查询:输入2858发至2858
北苑路5号2楼林之光科贸公司朝阳分公司

UK Football Pool Jackpot 12 Sample Ticket (12 Matches)


Jackpot 12
Statistics
11/11/2011 - International Fixtures
£55,292
Pool Size
Coupon
How to Play

	Home Team		Away Team	H	D	A
1.	Estonia	v	Rep of Ireland		✓	✓
2.	Turkey	v	Croatia	✓		
3.	Bosnia	v	Portugal	✓		
4.	Poland	v	Italy		✓	✓
5.	Denmark	v	Sweden	✓		
6.	Mexico	v	Serbia	✓		
7.	Belgium	v	Romania		✓	
8.	Cyprus	v	Scotland			✓
9.	Greece	v	Russia		✓	
10.	Panama	v	Costa Rica			✓
11.	Uruguay	v	Chile	✓		

Note:

1. *Shengfu* Game is very similar to Jackpot 12. One apparent difference is the former is composed of 14 matches instead of 12 matches.
2. In *Shengfu* Game, “3” denotes Home Team Wins, “1” Draw/Tie, and “0” Away Team Wins.
3. In Jackpot 12, “H” denotes Home Team Wins, “D” Draw/Tie, “A” Away Team Wins.

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Lunhua Mao, from the People's Republic of China, completed his Doctor of Philosophy degree in health and human performance (concentration: sport management) from the University of Florida in August 2013. He is a recipient of the University of Florida Alumni Graduate Fellowship. Prior to coming to the Gator Nation, Mao worked for the international affairs office at Shanghai University of Sport, China.

Mao has been actively participating in research projects within and outside of the college, including the 21st Century Community Learning Centers project funded by the Florida Department of Education, the gambling problem and corporate social responsibility project funded by the National Foundation of Philosophy and Social Science of China, and the sports sponsorship and branding effects project funded by the Shanghai Sports Bureau of China. He has published his research in *Sport, Business, and Management; Journal of Gambling Studies*; *Journal of Customer Behaviour; Journal of Applied Marketing Theory*; and *International Journal of Sports Management and Marketing*.

Mao was a representative of P. R. China at the IOC 7th International Session for Educators and Officials. He has presented his research findings at the North American Society for Sport Management, Sports Marketing Association, Association of Marketing Theory and Practice, and other conferences. He has also served as an ad hoc reviewer for several academic journals and conferences, including *Sports Management Review*; *International Journal of Sport Marketing & Sponsorship; Measurement in Physical Education and Exercise Science*; *Journal of Sports Communication;* and *Sport, Business, and Management.*