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An economic analysis of addictive behavior: The case of gambling

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City University of New York, 1990

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A

AN ECONOMIC ANALYSIS OF ADDICTIVE BEHAVIOR:

THE CASE OF GAMBLING

by

PAMELA MOBILIA

A dissertation submitted to the Graduate Faculty in Economics in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York.

1990

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This manuscript has been read and accepted by the Graduate Faculty in Economics in satisfaction for the degree of Doctor of Philosophy.

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Abstract

AN ECONOMIC ANALYSIS OF ADDICTIVE BEHAVIOR:

THE CASE OF GAMBLING

by

PAMELA MOBILIA

Advisor: Professor Michael Grossman

This dissertation applies a theoretical model of rational addictive behavior to gambling and tests the hypotheses of the model empirically using data on pari-mutuel betting at horse tracks from 1950 through 1987. Gambling demand equations which explicitly account for the fact that gambling is an addictive behavior are derived from the Becker-Murphy theoretical model of rational addictive behavior. The effectiveness of changing the takeout rate, the price variable in gambling, is examined within the addictive framework.

A brief summary of the increased availability of gambling is followed by a review of non-economic and economic literature. The various factors which distinguish the consumption of addictive goods from other consumer goods are then discussed, particularly as they relate to gambling. After a discussion of the theoretical model, gambling demand equations are derived under the competing hypotheses of non-addictive and addictive behavior and myopic and rational behavior.

Using instrumental variables techniques, various gambling demand equations are estimated, with the results generally

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supporting the hypothesis of the model of rational addictive behavior. In particular, significant intertemporal linkages are found in gambling consumption, confirming the assumption that gambling is addictive. Future events are found to have a significant impact on current consumption, implying that individuals are not behaving myopically. The long run price elasticities of demand implied by the estimates obtained for the addictive demand equations for handle per attendant range from -0.50 to -2.49, significantly larger than those obtained from demand equations estimated under the hypothesis of non-addictive behavior. This reaffirms the fact that the takeout rate is an effective policy instrument for state governments as they set the price of gambling.

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Chapter One

Introduction

Economists have historically treated the consumption of addictive goods in the same manner that they treat other consumption goods. However other social and natural scientists have acknowledged the fact that addictive goods possess characteristics not inherent in other consumption goods.

Consuming goods such as gambling, alcohol, drugs, and cigarettes was not thought to conform to rational, utility-maximizing behavior normally dealt with by economists. Some economists have treated the consumption of such goods as irrational and therefore, conventional economic analysis would not yield robust results. Because of this irrationality, the thought has been that the relationship between the consumption of an addictive good and its price is not inverse, a violation of the basic law of economics. In the case of gambling there are also factors such as negative financial effects of consumption and possible legal sanctions against consuming the good, in addition to its monetary price. The argument has been made that policies such as stronger enforcement of gambling and drug laws, higher fines and longer imprisonment for breaking the laws, higher taxes on gambling, alcohol, and cigarettes, and the dissemination of information concerning the possible negative effects of gambling, drugs, alcohol, and tobacco will have little, if any effect on consumption.

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Becker and Murphy (1986, 1988) have developed a theoretical model of addiction and outlined its empirical predictions. Recently, other attempts have been made to test empirically the consumption of an addictive good as rational behavior as modelled by Becker and Murphy [Becker, Grossman, and Murphy (1990), Chaloupka (1988), (1990a), (1990b)]. These models capture the distinction between the consumption of other goods and the consumption of addictive goods by recognizing that with an addictive good current consumption depends on the level of past consumption and that future consumption will be dependent on current consumption.

The time dependence of consumption in the Becker-Murphy model incorporates the notion of tolerance, reinforcement, and withdrawal which are generally used to separate addictive and non-addictive substances.

Tolerance implies a decrease in the body's response to a good as its use is continued, or that more of the good must be consumed to reach the same level of satisfaction. Reinforcement can be either positive or negative. Positive reinforcement is achieved when some pleasurable reward obtained from an activity leads to an increase in that activity. Negative reinforcement is achieved when an action terminates or prevents some unpleasant sensation such as gambling to provide relief from a stressful or traumatic life situation. Withdrawal is a physical reaction resulting from the cessation of consumption. Each element of addictive

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behavior illustrates the dependence of current consumption on past consumption: tolerance through the reduced effects of current consumption as past consumption is larger, reinforcement through the learned responses to past consumption and withdrawal through the negative physical reaction as consumption is terminated.

This paper will use and extend the model of rational addiction developed by Becker and Murphy and will test the implications of the model empirically using aggregate data on betting at thoroughbred horse and greyhound dog tracks and on lotteries in the United States. The addictive behavior being studied is gambling.

Gambling is a good choice for the empirical testing of a theoretical model of rational addiction. Gambling has recently been recognized by the psychiatric community as addictive behavior [Lesieur and Custer (1984a), (1984b)]. Until recently it was viewed as habitual behavior. Another important factor is that gambling is widespread in today's society. More than two-thirds of the population gambles in some form.

Due to the high level of incidence of gambling and the legality of much of the activity, measures of gambling are likely to be much more reliable than measures of some addictive substances such as heroin or other drug use. States require extensive reporting of consumption mainly for taxing purposes.

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Just as important as the reliability of the data on the consumption of the addictive good is the accuracy of the data on the price of the good. To gain meaningful insight into the responsiveness of gamblers to policies affecting the price of the gambling, the data on prices must be reliable. Data on gambling prices are regulated by state commissions and are reported at the state and local level. [American Racing Manual (1951 through 1988), Summary of State Pari-Mutuel Tax Structures (1967 through 1986)].

Also relevant in understanding the importance of research on gambling behavior is the argument that it imposes a significant burden on the rest of society. If gambling posed few or no problems for society and/or individuals, then research on gambling would have little importance. However, arguments against gambling have suggested that it imposes a tremendous burden on society and individuals. Lesieur and Custer (1984a), (1984b) estimate that somewhere between 10 and 15 people are directly influenced by a pathological gambler. These include spouses, children, parents, close relatives, fellow gamblers, people borrowed or stolen from, employers and employees. Church groups have argued against gambling to maintain the moral structure of the society. Sociologists have tried to determine whether the increased availability of gambling induces the presence of organized crime, as well as studying the effects of gambling on family structure which may end in financial ruin. Over the past several years, it has

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been established that gambling has been the fastest rising source of revenues to the states. Economists have argued that gambling forms are a regressive form of taxation while others call it a painless tax [Clotfelter and Cook (1987), (1989); Adar (1976); Borg and Mason (1988); Brinner and Clotfelter (1975)]. But it is also apparent that greater availability of gambling is positively correlated with the incidence of pathological gambling [Lesieur and Custer (1984a), (1984b)].

Simultaneous with the legalization of many forms of gambling, many states require a portion of the gambling revenues to be set aside to combat compulsive gambling. This is in contrast to the fact that many state governments have been involved in a concerted effort to encourage gambling through lottery advertising. This effort doesn't include any restrictions similar to those placed by cigarette advertising requiring health warning labels.

There is no mention of odds during commercials or advertisements. Some have criticized the advertising to be blatantly unfair in the sense it promises that you will win the money (which is really an annuity with a low present discounted value) or by the fact that it is selling fantasies or dreams [Blanche (1950)].

This paper focuses primarily on the policy in the gambling campaign, price increases through takeout rates and the increased legality of gambling. These are considered because data are used from a period over which there was

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significant cross sectional variation in the price of gambling. In 1950, takeout rates for win, place, and show bets ranged from 10% to 15% and in 1987 ranged from 15% to 20%. There is little evidence that state governments use takeout rates to discourage gambling and even less evidence that it is used primarily as a means raising revenues.

During the period covered in this research, there was a significant amount of activity at the state level in legalizing gambling [Abt and Smith (1983); Abt, Smith and Christiansen (1985); Blakey (1979); Blakey and Kurland (1978), (1984)]. This paper will be among the first attempts to empirically analyze the increased legality of gambling on the amount of gambling and will extend prior demand studies to include the possibility of addiction.

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Chapter Two

Availability of Gambling in the U.S.

Table 2-1 summarizes jurisdictions which offer various types of gambling. For pari-mutuels, in 1987, seventeen states have made greyhound racing legal. Fourteen of these states currently have greyhound tracks operating within the states. Forty states have some form of legal horseracing. Twenty-eight of these states currently have thoroughbred tracks operating within the state. Table 2-2 identifies states which offer greyhound racing and Table 2-3 identifies states which offer horse racing.

Interstate intertrack wagering is legal in twenty-four states and twenty-three states have operating systems. This system permits tracks within a state to accept wagers on races occurring outside of the state. Intrastate intertrack wagering is legal in twelve states and seven states have operating systems. Tracks within a state are permitted to accept wagers on each other's races.

Off track betting is legal in three states and is operative in two. One state, Connecticut, has off track betting but does not have any horse tracks. It allows betting on New York State tracks. Teletheaters are legal in ten states and are operative in five states. Teletheaters include any non-racing facility that shows live racing on a screen or television monitor and may include off track betting parlors. Table 2-4 identifies the states which offer interstate

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intertrack wagering, Table 2-5 identifies states with intrastate intertrack wagering, Table 2-6 identifies states with teletheaters and Table 2-7 identifies states with off track betting. Table 2-10 explains how pari-mutuel betting works.

Lotteries are legal in some form in twenty-eight states and the District of Columbia. Four other states, Idaho, Virginia, Indiana and North Carolina, have referendums on the establishment of a state lottery. Table 2-8 identifies states with lotteries and Table 2-9 identifies the start date of the various types of games they offer.

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Table 2-1

Number of Jurisdictions with Legal and Operating Gambling Establishments -- By Type of Gambling - 1987

	Legal	Operating
Greyhound Racing	16	13
Horseracing	40	28
Interstate intertrack wagering	24	23
Intrastate intertrack wagering	12	7
Off track betting	3	2
Teletheaters	10	5
Lotteries-total	29	24
Instant games	26	24
On line lotto	22	22
On line numbers	20	18
Passive games	15	0
Video lottery terminals	3	0

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Table 2-2

States with Greyhound Racing - 1987

State	Status
Alabama	Operating
Arizona	Operating
Colorado	Operating
Connecticut	Operating
Florida	Operating
Idaho	Authorized but not yet implemented
Iowa	Operating
Kansas	Authorized but not yet implemented
Massachusetts	Operating
Nevada	Permitted by law and previously operative, not currently operating
New Hampshire	Operating
Oregon	Operating
Rhode Island	Operating
South Dakota	Operating
Vermont	Operating
West Virginia	Operating

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Table 2-3

States with Horse Racing - 1987

State	Status
Alabama	Operating
Arizona	Operating
Arkansas	Operating
California	Operating
Colorado	Permitted by law and previously operative, not currently operating
Connecticut	Authorized but not yet implemented
Delaware	Operating
Florida	Operating
Idaho	Operating
Illinois	Operating
Iowa	Authorized but not yet implemented
Kansas	Authorized but not yet implemented
Kentucky	Operating
Louisiana	Operating
Maine	Permitted by law and previously operative, not currently operating
Maryland	Operating
Massachusetts	Operating
Michigan	Operating
Minnesota	Operating
Missouri	Authorized but not yet implemented
Montana	Operating
Nebraska	Operating

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Table 2-3 continued

States with Horse Racing - 1987

State	Status
Nevada	Permitted by law and previously operative, not currently operating
New Hampshire	Operating
New Jersey	Operating
New Mexico	Operating
New York	Operating
North Dakota	Authorized but not yet implemented
Ohio	Operating
Oklahoma	Operating
Oregon	Operating
Pennsylvania	Operating
Rhode Island	Permitted by law and previously operative, not currently operating
South Dakota	Operating
Tennessee	Authorized but not yet implemented
Vermont	Permitted by law and previously operative, not currently operating
Washington	Operating
West Virginia	Operating
Wisconsin	Authorized but not yet implemented
Wyoming	Operating

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Table 2-4

States with Interstate Intertrack Wagering - 1987

State	Status
Arizona	Operating
California	Operating
Colorado	Operating
Delaware	Operating
Florida	Operating
Idaho	Operating
Illinois	Operating
Kentucky	Operating
Louisiana	Operating
Maryland	Operating
Massachusetts	Operating
Michigan	Operating
Minnesota	Operating
New Hampshire	Operating
New Jersey	Operating
New Mexico	Operating
New York	Operating
Ohio	Operating
Oklahoma	Operating
Pennsylvania	Operating

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Table 2-4 continued

States with Interstate Intertrack Wagering - 1987

State	Status
Vermont	Permitted by law and previously operative, not currently operating
Washington	Operating
West Virginia	Operating
Wyoming	Operating

Table 2-5

States with Intrastate Intertrack Wagering - 1987

State	Status
Arizona	Operating
California	Operating
Colorado	Operating
Illinois	Operating
Kentucky	Authorized but not yet implemented
Minnesota	Authorized but not yet implemented
New Jersey	Operating
New York	Operating
Oklahoma	Operating
South Dakota	Authorized but not yet implemented
Washington	Authorized but not yet implemented
West Virginia	Authorized but not yet implemented

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Table 2-6

States with Teletheaters - 1987

State	Status
Arizona	Operating
California	Operating
Connecticut	Operating
Florida	Authorized but not yet implemented
Illinois	Authorized but not yet implemented
Nevada	Operating
New York	Operating
South Dakota	Authorized but not yet implemented
Washington	Authorized but not yet implemented
Wyoming	Authorized but not yet implemented

Table 2-7

States with Off Track Betting - 1987

State	Status
Connecticut	Operating
Illinois	Authorized but not yet implemented
New York	Operating

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Table 2-8

States with Lotteries - 1987

State	Status
Arizona	Operating
California	Operating
Colorado	Operating
Connecticut	Operating
Delaware	Operating
Florida	Authorized but not yet implemented
Illinois	Operating
Iowa	Operating
Kansas	Authorized but not yet implemented
Maine	Operating
Maryland	Operating
Massachusetts	Operating
Michigan	Operating
Mississippi	Operating
Missouri	Operating
Montana	Operating
New Hampshire	Operating
New Jersey	Operating
New York	Operating
Ohio	Operating
Oregon	Operating
Pennsylvania	Operating
Rhode Island	Operating

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Table 2-8 continued

States with Lotteries - 1987

State	Status
South Dakota	Authorized but not yet implemented
Vermont	Operating
Washington	Operating
District of Columbia	Operating
West Virginia	Operating
Wisconsin	Authorized but not yet implemented

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Table 2-9

LOTTERY START DATES FOR VARIOUS GAMES

STATE	INSTANT GAMES	3 DIGIT NUMBERS	4 DIGIT NUMBERS	LOTTO	GAME	# PER WEEK
Arizona	7/ 81			10/ 84	6-36	1
				9/ 84	6-39	1
Calif.	10/ 85			10/ 86	6-49	1
Colorado	1/ 83					
Conn.	9/ 75	3/ 77	11/ 84	11/ 83	6-36	1
				4/ 85	6-40	1
				4/ 86	6-40	2
Del.	11/ 75	1/ 78	1/ 80	4/ 83	6-30	1
				3/ 84	6-30	2
				11/ 86	6-34	2
D.C.	8/ 82	8/ 83	3/ 85	4/ 84	5-40	1
				11/ 85	6-36	1
				10/ 86	6-36	2
Ill.	10/ 75	2/ 80	2/ 82	3/ 83	6-40	1
				5/ 84	6-44	1
				1/ 86	6-44	2
Iowa	8/ 85			4/ 86	6-30	1
Kansas	3/ 87					
Maine	6/ 75	6/ 80	7/ 85	9/ 85	6-30	1
				1/ 86	6-36	1
Maryland	2/ 76	7/ 76	4/ 83	12/ 82	6-30	1
				5/ 83	6-36	1
				7/ 84	6-36	2
Mass.	11/ 73	4/ 76		8/ 84	6-40	1
				8/ 85	6-40	2
				4/ 86	6-44	1
Michigan	10/ 75	6/ 77	10/ 81	10/ 86	6-39	1
Miss.	1/ 86					
Missouri	12/ 86					
Montana	6/ 87					

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Table 2-9 continued

LOTTERY START DATES FOR VARIOUS GAMES

STATE	INSTANT GAMES	3 DIGIT NUMBERS	4 DIGIT NUMBERS	LOTTO	GAME	# PER WEEK
N.H.	1/ 74	3/ 77	9/ 86	1/ 64	na	1
		8/ 82		9/ 85	6-30	1
				1/ 86	6-36	1
N.J.	6/ 75	5/ 75	6/ 77	6/ 71	na	1
				5/ 80	6-36	1
				6/ 84	6-39	1
				1/ 86	6-42	2
New York	9/ 76	9/ 80	7/ 81	11/ 78	6-40	1
				10/ 83	6-44	2
				5/ 85	6-44	1
				6/ 85	6-48	2
Ohio	6/ 76	12/79	4/ 81	4/ 83	6-40	1
				10/ 84	6-40	2
				2/ 86	6-44	1
Oregon	4/ 85		3/ 87	11/ 85	6-38	1
				6/ 86	6-42	1
Penn.	5/ 75	3/ 77	11/ 80	4/ 82	6-40	1
				7/ 83	6-40	2
				3/ 85	6-40	3
				8/ 86	6-40	2
				8/ 86	7-11-80	1
R.I.	5/ 76	2/ 76		2/ 81	4-40	1
				8/ 83	4-47	2
				8/ 84	5-40	3
Vermont	2/ 78	9/ 82	9/ 85	9/ 85	6-30	1
				1/ 86	6-36	1
Wash.	11/ 82	1/ 84		7/ 84	6-40	1
				11/ 85	6-44	1
W.V.	1/ 86		2/ 87	11/ 86	6-30	1

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Table 2-10

EXPLANATION OF PARI-MUTUEL BETTING

(adapted from the American Racing Manual)

The distinguishing feature of pari-mutuel betting is that the public makes the odds. Each bettor wagers whatever amount pleases them on the horse or dog of choice. Another feature is the absolute fairness of the system. Wagering is done by purchasing tickets for horses or dogs selected. Tickets are usually in $2.00 denominations, however, tickets for larger denominations are available for those who wish to wager large sums of money. Tickets are sold for the horse to win, place (run second), or show (run third). There is no limit to the number of tickets that one may purchase. Each ticket sold is recorded in a computer as soon as it is sold. The total sales on each entry in each pool and the pool totals are displayed every 90 seconds. When a race is decided, a percentage or takeout of the total amount wagered is deducted for the track and state. The remainder is divided and paid to the holders of winning tickets.

An example is presented to illustrate how pari-mutuel betting works and how the amount paid is derived. The following hypothetical horse race, that has ten horses running will be used.

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Table 2-10 continued

Horses	Number of $2 tickets Straight Win Bets
Turkey Trot	825
Ribbons	563
Candy Cane	658
Amber	445
Stetson	365
Old King	258
Paper Chase	102
Othello	96
Fair Guess	72
Kim's Luck	49
	=========
	3433

Suppose Turkey Trot won the race, Ribbons came in second, and Othello came in third. The following method would be used to determine the value of a straight winning bet on Turkey Trot:

Total number of straight tickets sold	3433.00
Multiply number of tickets by price to obtain the dollar amount	6866.00
Deduct the takeout (assume 10%)	-686.60
	=========
Net amount to be shared among winners	6179.40
Divide by the number of tickets sold on Turkey Trot	7.49

Each $2 bet on Turkey Trot therefore returns to the buyer $7.49. This sum includes the $2 paid for the ticket, making the net profit $5.49. Fractions of less than 10 cents (assuming 10 cent breakage) are withheld and distributed according to state laws. The winners would receive $7.40 in this instance.

The following example shows the method used to determine the value of a place bet on Turkey Trot or Ribbons:

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Table 2-10 continued

Horses	Number of $2 tickets Straight Place Bets
Turkey Trot	723
Ribbons	562
Candy Cane	542
Amber	361
Stetson	126
Old King	256
Paper Chase	118
Othello	86
Fair Guess	142
Kim's Luck	45
	=========
	2961

Place backers of Turkey Trot and Ribbons would win and receive as follows:

Total number of straight place tickets sold	2961.00
Multiply number of tickets by price to obtain the dollar amount bet	5922.00
Deduct the takeout (assume 10%)	-592.20
	=========
Net amount to be shared among winners	5329.80
Add together the number of place tickets sold on Turkey Trot and Ribbons	1285
Multiply number of tickets by price to obtain the dollar amount bet	2570.00
Deduct from total net amount to share among winners (the total to be divided)	2759.80
Divide this amount by two	1379.90

Divide the halves by the number of place tickets sold on Turkey Trot (1379/723 = 1.91) and on Ribbons (1379/562 = 2.46). To these amounts, the $2 bet must be added back. This brings the total amount paid to the backers of Turkey Trot $3.91 and to the backers of Ribbons $4.46. Fractions of less than 10 cents (assuming 10 cent breakage) are withheld and distributed according to state laws. The winners would

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Table 2-10 continued

receive $3.90 and $4.40 respectively in this instance.

The following shows the method used to determine the value of a show bet on Turkey Trot, Ribbons or Othello:

Horses	Number of $2 tickets Straight Show Bets
Turkey Trot	921
Ribbons	658
Candy Cane	152
Amber	364
Stetson	455
Old King	263
Paper Chase	185
Othello	92
Fair Guess	112
Kim's Luck	84
	=========
	3286

When people wager on horses to run third or show, the method of calculating the winnings are similar to the place bets except that the sum remaining is divided into three equal parts instead of two.

Total number of straight tickets sold	3286.00
Multiply number of tickets by price to obtain the dollar amount bet	6572.00
Deduct the takeout (assume 10%)	-657.20
	=========
Net amount to be shared among winners	5914.80
Add together the number of tickets sold on Turkey Trot and Ribbons and Othello	1671
Multiply number of tickets by price to obtain the dollar amount bet	3342.00
Deduct from total net amount to share among winners (the total to be divided)	2572.80
Divide this amount by three	857.60

Divide the thirds by the number of show tickets sold on Turkey Trot (857.60/921 = .93), on Ribbons (857.60/658 = 1.30), and

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Table 2-10 continued

on Othello (857.60/92 = 9.32). To these amounts, the $2 bet must be added back. This brings the total amount paid to the backers of Turkey Trot $2.93, the backers of Ribbons $3.30 and to the backers of Othello $11.32. Fractions of less than 10 cents (assuming 10 cent breakage) are withheld and distributed according to state laws. The winners would receive $2.90, $3.30 and $11.30 respectively in this instance.

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Chapter Three

Related Literature

Gambling has been researched by scientists in different areas including economics, sociology, psychology, public policy, and medicine. Each field takes a different view of gambling and a summary of the research follows.

I. Pathological Gambling

Lesieur and Custer (1984a), (1984b) reveal that the bulk of people are social gamblers, where gambling is only an enjoyable pastime. It is difficult to detect potential problems and imminent compulsive behavior. Probable compulsive gamblers have a "chronic & progressive failure to resist impulses to gambling and gambling behavior, a failure that compromises, disrupts, or damages personal, family, or vocational pursuits" (p. 147).

Features of compulsive gambling are emotional dependence on gambling, loss of control, and gambling's interference with normal functioning. In earlier times a person who gambled beyond their means was viewed as a sinner or criminal. Gradually, this view was challenged. A medical or illness model was embraced, implying that treatment rather than moral condemnation was needed.

There are six distinctive developments that impacted the traditional image of the compulsive gambler.

1. There has been an increased incidence of legalized gambling. Thus, the number of pathological gamblers has

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increased.

2. An inpatient treatment program for compulsive gamblers was initiated by the Veterans Administration at the Brecksville, Ohio Medical Center at the request of a local Gamblers Anonymous Chapter.

3. The National Council on Compulsive Gambling was formed. Its mission is to educate the public that compulsive gambling is a treatable illness.

4. The Commission on the Review of National Policy toward Gambling surveyed the population to discover the extent of compulsive gambling by making a survey of the U.S. to determine the extent of compulsive gambling.

5. The American Psychiatric Association in 1980 recognized pathological gambling as a "disorder of impulsive control" in the third edition of its Diagnostic and Statistical Manual.

6. Treatment programs have been established in Maryland, Connecticut, New York, and New Jersey.

The traditional image of the degenerate gambler, addict, or compulsive gambler is being displaced by one more reflective of a medical model of addiction. The medical model has incorporated the idea of restitution to compulsive gamblers.

II. Roots and Causes

Sociocultural factors influence gambling and the presence of pathological gambling. Studies [Custer and Custer (1978),

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Livingston (1974), and Lesieur (1977)] have shown Italians, Jews, and the Irish are over represented among pathological gamblers in Gamblers Anonymous and in various other treatment methods. The Gambling Commission survey found Italians, Spanish speaking persons, Asians and American Indians to be over represented but not Jews or Irish [Kallick et. al. (1979)]. These studies have also shown that compulsive gambling crosses sociocultural boundaries. There have been studies and reports of compulsive gamblers in Nepal, Bali, France, England, and among Native Americans and Indians (p. 148).

Greater availability of gambling appears to be correlated with pathological gambling [Lesieur and Custer (1984a), (1984b), Kallick et. al. (1979)]. However, the availability of gambling should not be equated with pathological gambling.

Sociologists have presented various explanations of pathological gambling. Pathological gambling is produced by a "defective relationship between strategy of play on the one hand and a way of managing one's finances on the other," [Oldman (1978)]. Gamblers lose for three reasons: inexperience and imperceptive or bad play; erroneous ideas about cards, dice, etc.; and inept money management. Inept money management (called "chasing" by gamblers) becomes part of a self enclosed system that reinforces and creates further pressures to continue gambling despite losses.

Skinner (1953) says, people become addicted to gambling

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through a pattern of intermittent reinforcement. Those who have had winning histories despite some losses, have patterns of positive reinforcement. Because of the random yet intermittent rewards, this pathological gambling behavior becomes more difficult to stop. This idea has been supported by Moran (1970) and Custer (1982). These studies presented evidence that the career of the pathological gambler involves the presence of a big win in the early stages supporting the view that pathological gamblers have had periods positive reinforcement that convincing them of the benefits of gambling.

Bergler (1969) uses psychoanalytical language to explain pathological gambling behavior. He states that gamblers are masochists who try to lose in an effort to expiate some unconscious source of guilt. Lesieur and Custer (1984a), (1984b) report that there is little empirical evidence supporting Bergler's contention. Most pathological gamblers have an early winning phase lasting three to five years. Masochists couldn't stand to win for that long.

Lesieur and Custer (1984a), (1984b) report that some scientists believe that underlying personality traits are the cause of pathological gambling. Studies on pathological gamblers show that they tend to have higher scores than national norms on achievement, exhibition, dominance, heterosexuality, deference and endurance on the Edwards Personal Reference Schedule. Similar studies using the

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Minnesota Multiphasic Personality Inventory have found pathological gamblers to have high scores on the psychopathic deviation (Pd) scale, and many showed clear signs of depression when tested. The elevated Pd scores indicate that close to half of the pathological gamblers conform to the profile of sociopathic personality disturbance. A sociopathic person is typically unable to gain and learn from experience, lacks personal and group loyalties, has defective judgement and responsibility, and is able to rationalize and justify individual behavior. These studies do not tell the direction of causation or which comes first, the personality or gambling.

Pathological gamblers have certain physiological traits, such as high energy levels, hyperactivity, and high tolerance of stress. All studies point to higher IQ among pathological gamblers than in the general population. However, this may be that people with higher IQ's seek out treatment.

III. Types of Pathological Gamblers

Lesieur and Custer (1984a), (1984b) report five types of personality traits used to explain pathological gambling behavior.

1. subculture variety - people whose gambling is understood in terms of social setting;
2. neurotic variety - those who gamble with money, rather than for money;
3. impulsive variety - those who lose control of

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themselves or have ambivalence toward the activity;

4. <u>psychopathic variety</u> - those for whom gambling is only part of some underlying global disturbance; and,

5. <u>symptomatic variety</u> - those for whom gambling is associated with mental illness.

Sociologists make distinctions primarily on social class and group orientation. Cases have been made for working class and middle class styles of compulsive gamblers. Another distinction is between loners, who are mainly middle class; group-oriented, who typically are working class; and action system players, who are involved in a twenty-four hour a day action system chiefly devoted to hustling with other pathological gamblers.

IV. Phases of the Gambler's Career

There has been much dispute over the cause or types of pathological gamblers. However, studies do show similarities in the progression of increased involvement in gambling activities. Lesieur and Custer report three stages of pathological gambling: winning, losing, and desperation.

The <u>winning</u> or adventurous stage introduces the gambler to gambling as an enjoyable pastime. Gambling is fun, exciting, and enjoyable and additional pleasure is obtained by winning. Pleasure is expressed in terms of self esteem as well as the physiological pleasure and pain of wagering. The winning, and in particular the big win, establishes in the mind of the compulsive gambler that it can happen and could

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happen again, and could be even larger.

The gambler views the big win as being generated by some personal ability or inherent personal luck. The gambler believes that the system of playing, wagering, or handicapping is somehow superior to other people's methods. Losses are explained away as some exogenous force such as bad luck, bad inside information, or cheating by others.

The gambler at this stage wins and loses but often breaks even. Winnings are respent on additional gambling. Losses are rationalized. Borrowing to cover losses is mainly to prolong the entertainment that gambling provides.

The middle stage of the pathological gambler's career is the <u>losing</u> phase. The gambler is convinced that chasing is a smart strategy. The gambler borrows money to cover losses and get even. These loans are a threat to self esteem as well as a financial threat. The gambler hides the fact of borrowing from spouse or close relatives. The gambler becomes aloof and mentally "a million miles away" when participating in gambling systems, sports, cards, and other wagering.

To recover losses, the gambler spends an increasing amount of time gambling. Work interferes with gambling activities. Gambling world connections have often introduced the gambler to more and different types of gambling. The gambler views these alternatives as a source of financial relief. Sometimes gamblers become bookmakers or hustlers.

Borrowing increases in frequency and sources. The

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gambler often becomes a loner to avoid discussing the financial situation. Fraudulent credit statements, civil fraud (bad check writing) or forgery are often used to increase available funds. However, the gambler is still convinced that they will be able to repay all that is borrowed.

As the gambler panics and becomes increasingly desperate, bailouts (usually with a tacit agreement from the gambler to stop gambling), are necessary. However they tend to encourage unreasonable optimism, and create an illusion in the gambler's mind that nothing bad can happen.

The third stage is <u>desperation</u>. The gambler becomes obsessed with getting even and paying all debts sometimes triggered by a large bail out and subsequent losses. Gambling is now a full time endeavor. The gambler is alienated from family and relatives.

A state of panic sets in which produces increased risk and irrational gambling. Gamblers become restless, irritable and hypersensitive as sleep and eating are disturbed. At this stage a significant win leads only to heavier gambling and heavier losses. This leads to feelings of hopelessness and helplessness. As deep bouts of depression and suicidal thoughts occur, gamblers often feel that they have only four options. Suicide, imprisonment, running away (typically to Las Vegas or some other gambling heaven), or seeking help.

V. <u>Treatment</u>

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There are only two sources of help to gamblers: Gamblers Anonymous or professional counseling. Gamblers Anonymous is patterned after Alcoholics Anonymous. There have been no studies on the effectiveness of Gamblers Anonymous. It does not seem to be as successful as other self help groups, probably due to resistance to the illness model.

Brown (1987) analyzes relapse-provoking situations and the role of arousal in gambling addictions. Brown reports that:

1. gambling is very exciting measured by heart rate increases;
2. some form of arousal or excitement is a major reinforcer of gambling behavior for regular gamblers; and,
3. individual differences in sensation seeking are involved, as one of a number of determinants, in the behavior of many gamblers.

Early studies reveal that once started on episodes of betting, individuals continued to bet again. However, they did not explain the long term reinstatement phenomenon where time has no effect. After one episode of gambling ceases and the chain of reinforcement is broken, the situation is sought out again and a new episode is begun (which can be immediately or after years).

Irregular reinforcement schedules are only a means of producing this desired phenomenon, which is sought repeatedly

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even after each reinforcement schedule has been broken by a long time interval for other reasons than merely because of the addictive properties of the reinforcement schedule alone.

Tabor, McCormick and Ramiriz (1987) state that pathological gambling, as a diagnostic category, includes individuals with a variety of additional psychological problems including affective disorders, substance abuse, survivor syndrome, anxiety states, and significant depression.

They believe that gambling fills many of the same needs for the pathological gambler that alcohol or other psychoactive substances do for the chemical abuser. Gambling may include a mechanism for escaping into an altered state of consciousness, or a means of "numbing." Gambling may be a response to dysthymia and "affect intolerance," a mechanism proposed as critical in alcohol abuse.

While collecting information on subjects entering treatment programs for pathological gambling an overlap in symptomatology between post traumatic stress disorder and pathological gambling was found. They suggest studying the history of trauma in compulsive gamblers and to attempt to correlate the presence of significant trauma with other psychological and behavioral factors. Admissions to the Cleveland Veterans Administration Medical Center were studied. Table 3-1 describes the characteristics of patients.

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Table 3-1

Characteristics of Patients at Cleveland Veterans Administration Medical Center

Variable	Mean	Std. Dev.	Range
Age (years)	42.4	12.2	23-73
Education	12.6	2.1	8-19
Age Pathological Gambling began (years)	26.3	9.5	15-55

MARITAL STATUS	Percentage
Single	20
Married	52
Divorced	23
Separated	2
Widowed	2

WORK EXPERIENCE	Percentage
Professional	11
Skilled	36
Unskilled	52

RELIGION	Percentage
Catholic	55
Protestant	25
Jewish	7
Unspecified	14

PRIMARY MODE OF GAMBLING	Percentage
Casino	16
Horseracing/dog racing	32
Cards	20
Sports	16
Stock/Commodities	7
Poker Machines	7
Bingo/Lotteries	2

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Table 3-1 continued
Characteristics of Patients at Cleveland Veterans Administration Medical Center

ETHNICITY	Percentage
Caucasian	93
Black	7

PREVIOUS TREATMENT	Percentage
Gambling	43
Other Addictions	16

OTHER

23% reported experiencing severe trauma
16% moderately heavy trauma
30% less severe trauma
32% no serious life trauma

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The study attempted to extract a significant amount of information including age at the time of the first gambling experience, age when compulsive gambling began, major life stressors, age at which each stressor occurred, and an estimate of the impact of the major stressor on the patient.

The results show that 23% of patients reported experiencing severe trauma during their lives. 16% of the patients reported moderately heavy trauma during their lives, 30% reported less severe trauma, and 32% reported no serious life trauma.

The authors suggest that their sample of gamblers may be atypical because they were sufficiently in distress to seek inpatient treatment, and were all male veterans. However, the presence of major life stressors were significant and meaningful. Some patients had more than one major traumatic event during their life. They attempted to include both objective severity (events most people would find traumatic) and subjective severity (patient's perceived sense of impact and severity).

They report that patients who experienced severe life stressors, as compared to those who experienced none, had high levels of depression and anxiety and were more likely to be abusing drugs and alcohol.

The authors concluded that trauma is a major factor in the incidence of compulsive gambling. Gambling offers individuals the ability to escape from emotional trauma and

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the resulting chronic dysphoria. Gambling is an exciting activity which gamblers describe in a manner suggestive of altered state of consciousness similar to that experienced by chemical substance abusers. It could, therefore, be used to "numb" consciousness in much the same way that victims of post traumatic stress disorder often use alcohol or drugs. Gambling also provides immediate gratification in the insatiable quest for self-affirmation. When trauma occurs in an individual's life, there is a conditioned or learned affective reaction and a tendency to feel dysthymic and negative about oneself. This often creates an urge to avoid and escape. Gambling is a welcome mechanism. Gambling and its inevitable losses provides compulsive gamblers the needs to self-punish, a need for risk taking behavior which has been noted as a sequelae to post traumatic stress disorder. [Niederland (1967)].

Custer (1976), (1982) reveals that compulsive gambling is the type of disorder in which there is a progressive increase in the preoccupation and urge to gamble. The features are emotional dependence on gambling, loss of control, and interference with normal functioning.

Although we are now in a permissive phase, public attitudes remain essentially judgmental and moralistic toward compulsive gambling and the compulsive gambler. It seems moderate risk taking is more socially valued in our society than caution, but caution is infinitely more acceptable than

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reckless risk taking.

The availability of gambling seems to increase the risk of becoming a compulsive gambler and that legal gambling facilities seem to stimulate illegal gambling.

Pathologic gambling is used synonymously with compulsive gambling. Scientific groups prefer the term pathologic to compulsive because compulsions are the behavioral component of the obsessional state in which a person finds the abnormal behavior alien and attempts to resist it. If this element of resistance is not present the use of compulsive should be avoided. Pathological is a more appropriate term, since it is soleiy descriptive and is not based on any assumptions about conscious or unconscious motivations.

Custer (1982) provides many early conclusions of the serious efforts to understand compulsive gambling behavior. The earliest studies were made by psychoanalysts. Ernst Simmel explained gambling as an effort to gain narcissistic supplies such as food, love, comfort, and attention which the gambler feels have been denied. Wilhelm Steckel believed the gambler was a child playing and the adult had just regressed into childhood. He also felt that gambling behavior was from the desire to avoid work. Sigmund Freud explained that the passion was equivalent to the compulsion of masturbation (pp. 111-112).

Bergler's (1957) thesis was that the gambler is not simply a rational though "weak" individual who is willing to

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run the risk of failing and moral censure in order to get money the easy way, but a neurotic with an unconscious wish to lose it.

Ralph Greenson and I.E. Galdston believed that gambling was a neurotic defensive function to ward off feelings of impending depression. They found no support for Freud's formulation. B.F. Skinner's research was on operant conditioning. He felt that gambling was a cause of the influences of intermittent reinforcement. R.H. Thompson felt that running mild risks are inherently rewarding and that the arousal will always act as to produce an optimal level of excitation.

Anthropologists also studied gambling behavior and reported the influence of uncertainty reflected in magical thinking.

Sociologists deal with the availability of gambling, the social stresses and rewards, the limited options to the gambler as losses accrue, peer pressure, and the modeling of behavior.

Physiologists are impressed by the fact that gamblers show constitutional factors of brightness, high energy level, hyperactivity and high tolerance to stress.

Custer reports that only 10-15 percent of compulsive gamblers show some neurotic signs. Most gamblers are not guilt ridden, masochistic megalomaniacs striving to lose. Many had prolonged winning experiences. The causes of

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compulsive gambling are a confluence of psychological, social, cultural, and even biologic factors.

Frey (1984) presents the view that sociologists have about gambling. Sociologists have neglected gambling as an activity despite the fact gambling is popular among a majority of the population and that it is a persistent and institutionalized behavior. Gambling's popularity cuts across all class, racial, and ethnic lines and a greater proportion of any society are gamblers than are non-gamblers.

VI. Functional View

There are cultural demands for routine, order and predictability. On the other hand there is the pressure to experiment, to take chances, to be entrepreneurial. The latter is often impossible for most people. Therefore people seek activities that will provide a substitute or compensation for the lack of thrills and the dominance of order in their daily lives. Gambling and other aleatory activities fulfill personal needs and contribute to societal stability by displacing potentially disrupting forces.

Devereux (1949) rejected pathological and individualistic views of gambling in favor of an approach that acknowledged the continuous existence of gambling and that asked "How are these deviant behavior patterns fitted into the general frameworks of the social structure, and how is a tolerable condition of equilibrium established and maintained?"

It is not theoretically safe to assume that since

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gambling tends to evoke negative reactions and tends to remain illegal, it is dysfunctional and produced disruptive societal consequences. Rather the persistence of gambling behavior, despite its illegality, is testimony to the fact that gambling meets some societal needs; that need is essentially one of tension management.

The central theme of most functional analysis is that gambling is a safety valve institution, that it diverts feelings of hostility to substitute objects or it serves as a channel for cathartic release. Gambling is a mechanism for relieving strain in a socially acceptable, although not necessarily legal, manner.

Gambling fulfills various personal and social needs not fulfilled in the capitalistic systems that tend to carry built in frustrations. So gambling permits one to indulge in a protest against budgetary restraints and rationality while permitting thrill seeking, competitive aggression and problem solving, not usually permitted on the job or in the routine of everyday life.

Gambling is part of the counter mores in a system and it may co-exist within the same person or society without producing a disequilibrium [Devereux (1949)]. Participation in gambling reminds one of the main ethical theme of the culture, produces guilt and keeps the individual from going beyond the acceptable boundaries of participation in these vices. The act of disapproving gambling reinforces the moral

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order and the result is a stable personality organization and subsequent societal equilibrium.

Gambling is a mechanism of accommodation utilized by society to channel protestations resulting from frustration with the basic economic and ethical systems in a socially approved, and functionally imperative manner.

Gambling has also been viewed as dysfunctional since it is disruptive to a family, conducive to criminal activities and disruptive of an individual's capacity to work. Since most gambling is recreational rather than compulsive, these criticisms are not entirely valid. Recreational gambling could be permitted as long as it does not divert major resources. The same functional justification for the existence of gambling is associated with the existence of organized crime.

VII. Anomie, Alienation, Decision Making

Anomie theory, developed by Robert K. Merton addresses the cultural contradictions of the capitalist system namely the "nonalignment of cultural goals (i.e. success and structural conditions." Society puts pressures on persons to be successful, but denies equal access of the means of attaining this success. This results in a series of adaptations, one of which can be innovative behavior that calls for seeking approved goals via culturally unapproved means, namely illegal activities such as gambling. Gambling, thus, provides an opportunity to achieve a socially approved

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goal via culturally unapproved means such as gambling. This view has lead to an assertion that denied opportunity explains great deal of lower class and working class gambling.

Alienation theories suggest that these persons most frustrated on the job will be more likely to gamble. Frustration emanates from psychological feelings of powerlessness and a lack of job autonomy. Gambling provides the opportunity to gain feelings of self reliance and control not found on the job. The major testable proposition is that the lower the status of the job, the more likely it denies self expression and the more likely those in this type of job will gamble. Gambling breaks the stranglehold of this alienation by permitting thrill seeking and self indulgent behavior.

Alienation theories are complimented by those perspectives that focus on the decision making component of gambling. Gambling allows the person to exercise control. The individual is given the chance to weigh the costs and benefits of an action and to make what they feel is an appropriate decision. This kind of deliberation is not ordinarily possible in the gambler's daily activity, particularly work.

Zola (1963) presents a similar study of an illegal off track betting parlor and suggests a similar motivation for participants. By beating the system, or outsmarting it by rational means, subjects demonstrate that they can exercise

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control and that for a brief moment they can control their fate. Lower class gambling is predominantly associated with this pattern.

Each of these theories stresses the tension management or safety valve function of gambling, the major tenet of the functional approach. If there is not some outlet that deflects one's attention from the inconsistencies of the socio-cultural system, serious disruptions could occur.

VIII. Action Analysis and the Group Process

Most theories are class based and they tend to gear analyses to the exigencies of lower and working class life. These perspectives tend to be phased on a macroscopic level by focusing on the larger structural or cultural trends likely to be conducive to promote gambling behavior on the microscopic level. The theories emphasize the interactional component of participation in risk taking activities, notably gambling.

Goffman (1967) studied temporary interactional enterprises in natural settings. One such enterprise involves the deliberate seeking of risk taking. Action is found whenever the individual knowingly takes consequential chances perceived as avoidable. These action activities are consequential and fateful in that something of value can be won or lost on the outcome and, by committing something of value, players indicate their seriousness. The greater the consequences, the more fateful the enterprise becomes.

The pursuit of risk taking or action is highly valued in

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Western and American culture (p. 113). We still believe that the truest record of an individual's character is revealed in his or her reaction to fateful activities sought by choice. Gambling is an archetype of action of fateful activity. Gambling is a socially acceptable arena wherein action can be pursued.

By participation in action oriented settings one can demonstrate character or performance under stress. The person is judged not so much by demonstrated skill but by behavior of certain moral traits exhibited. These include courage, gameness, integrity, gallantry, compromise, and presence of mind. The attractiveness of action participation is not in its impulsive or irrational nature, but in the possibility of demonstrating character. Modern society provides very few possibilities for such an exhibition.

Tec (1964) made a survey of football betting by men in Sweden. The intention of the study was to test various assumptions about the possible negative impact of gambling on gamblers and society. Tec found the size of the bet increased with income. He concluded that bettors took their financial conditions into consideration, and therefore gambling did not produce financial hardships. This was true even for lower and working class bettors.

Tec investigated the proposition that gambling makes persons less productive at work or damages initiative for upward occupational mobility. More bettors than non-bettors

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were employed, 41% of bettors as opposed to 37% of non-bettors were enrolled in adult education to improve occupational condition, and an equal proportion of bettors versus non-bettors were engaged in on the job training programs. Tec demonstrated that the worse one's financial condition, the less likely one is to gamble. This finding contradicts anomie theory.

Tec also found bettors and non-bettors equally likely to be active in community affairs and to hold office in voluntary organizations and to vote in national elections. There is no support for the assertion that gambling is related to non involvement, an indicator of alienation.

Tec's data show that most myths about the harmful effects of gambling are not substantiated by research. The myths do not typically distinguish between the impacts of excessive addictive gambling and those produced by reasonable moderate participation.

These studies provide a great deal of background justification for public policy that was taking a more favorable view toward the legalization of gambling.

Tec also tested the relation between social class and betting. Tec tested opportunity theory and assumptions about lower class deviance. He found that the more accessible conventional channels were for the fulfillment of it was that one would gamble. This was especially true for the elite of the lower class, who had more contacts with upper class

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individuals and who were able to draw more comparisons with their lifestyles and their own relative deprivation. This produced aspirations for mobility, and these aspirations were confronted with obstacles because of the lack of preparation and qualifications required to achieve higher status. These frustrated individuals would turn to activities like gambling to provide hope, however temporary, of achieving their dreams. This demonstrates the relationship of the apparent inability to get ahead, gambling and opportunity. The data suggest that the propensity to gamble is not necessarily determined by social class characteristics, but rather to the extent to which upward mobility aspirations are held.

Wen and Smith (1976) studied the relationship between gambling propensity economic status, community size and status inconsistency.

These studies verified Veblen's assertion that the higher ones's income the more likely one is to gamble, but the finding was non-linear since at later stages of the life cycle (when one is earning a higher income), the propensity to gamble is lower.

Newman's (1968) study of a betting shop suggests that lower class gambling is not motivated by relative deprivation. Bettors were rejecting the characteristics of modern bureaucratic, middle class society in favor of a traditional, working class subculture.

Sociologists have also applied the theme of blocked

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opportunity and status frustrations to explanations for the existence of illegal enterprises. This perspective asserts that blocked conventional opportunity paths lead persons to seek illegal opportunity. These persons are rewarded for doing so with prestige from their peers.

Gambling is not necessarily a reaction to blocked aspiration or peculiar cultural beliefs. Rather it is a product of cultural tradition, location, and price.

IX. Patterns of American Gambling

A survey conducted in 1974 by the Michigan Survey Research Center for the Commission on the Review of the National Policy Toward Gambling presented comprehensive results on gambling behavior of Americans [United States (1976)]. 61% of Americans revealed that they had gambled during 1974 and 68% revealed that they had gambled at some time during their life. Only 11% ever participated in illegal betting. The propensity to gamble was greatest among males; residents of the Northeast; non-married; higher income brackets; of British, Irish, or African extraction; those who had attended college; and those living in suburban areas.

The survey concluded that betting was a universal phenomenon. The only groups in which less than half of the people gambled were those over 55; those with incomes less than $5000; widowed; Southerners; and without a high school degree. Most people revealed social reasons for betting such as to have fun or a good time. Some bet for excitement or for

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the challenge. Only few bet to make money, except for bets on lotteries. Most revealed that they would continue to bet if there were laws prohibiting it. Thus gambling seemed to be essentially rational behavior tied to "realistic assessment of income available."

There were large variations in profiles of bettors when volume of betting was considered. Light bettors reflected the distribution of the general population but tended to be those without a college education, Catholic, urban, and residing in the Northeast. Most played the lottery. Heavy bettors (more than $200 per year) tended to bet at the horse track and illegally, were more likely males, non-white, aged 25-44, divorced, earning moderate to high incomes, and living in the Northeast. Those employed bet slightly more than those unemployed.

Most non-bettors were from rural areas. An experience in the armed forces proved conducive to gambling, especially illegal gambling. The study concluded that an individual's exposure to gambling is the factor which distinguish gamblers from non-gamblers. Therefore as widespread legalization of gambling occurs, a greater proportion of the population will gamble.

X. Psychological View of Gambling

Igor Kusyszyn (1972), (1978), (1984) presents the psychological view of non-pathological gambling. He claims that the ratio of pathological to social gamblers is 1 to 100.

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Since approximately 60 percent of the population gambles, he feels that the activity warrants study. Gambling can be viewed in ways ranging from the physical surroundings of gambling activities to the state of mind of gamblers. Gambling is a self contained activity. It always has a special place for activity such as a race track, casino, card room, or bingo hall. It occurs most often, completely apart from the routine activities of everyday life. Gambling occurs during leisure time when basic physiological needs are satisfied. Participants independently and voluntarily select the game and their modes of participation in it. All three classical dimensions of humans are involved in gambling: COGNITIVE (decision making), CONATIVE (wagering) and AFFECTIVE (hope of winning or fear of losing).

Gambling is composed of continuous chains of events which include decision making, wagering, on outcome, emotional reaction to outcome, cognitive appraisal of one's actions in relation to the outcome, further decision making, further wagering and so on. Each chain is unique; although succeeding chains are always variations of previous chains, no chain is identical to any other. The novelty of each chain and the gambler's freedom to participate in it as a creative agent allow gambling to be an absorbing activity.

Gambling permits complete personal control of the degree of commitment to the activity. This can be altered at will. The gambler can be committed to a larger degree by making a

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larger wager.

During gambling, money loses its economic value. The gambler is seen to be playing with money rather than for it. Although money is not highly valued during the process, gamblers do recognize relative differences in the sizes of their wagers (i.e. a $50 wager is seen as larger than one of $20, but the $50 wager is not seen as equivalent to the price of a shirt). In casinos, plastic chips are used in place of money in order to devaluate money further. Gamblers will bet more in chips then they would in cash.

However money is essential to the gambling process. Without money one is "out of action." One can still make imaginary bets when one is broke, but with such wagers, there is only token involvement; gamblers do not get excited or aroused to any noticeable degree when there is an imaginary bet. Even though money loses its economic value, it retains an incentive value that provides for the continuation of the activity.

Gambling provides for the exercising of biological and psychological urges. It can increase muscle tension, speed the heart rate, and create emotional arousal with both enthusiasm, and euphoria or with anxiety, fear or disappointment.

Gambling provides for the operation of cognitive emotional states involving the self. It can elicit pride, courage, self esteem, self blame and self remonstration.

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Gambling provides an opportunity to experience other emotions such as anger, hostility, and aggression and to externalize these states to others.

Gambling is a release from reality as gamblers transport themselves into a play world and stay there suspended until jarred back into reality by the finish of the last race or the disappearance of their money. While in this fantasy world, they can and usually do, act, feel and think with abandon, without super ego control, and without psychological defenses. They are on a mental midway. [The free child of Eric Berne, the id of Sigmund Freud, or the instinctional impulses of Abraham Maslow emerge from the gamble.] It is this disinhibited released self that is most evident in the gambling situation. [Recall for example, the difficulty of maintaining a poker face in card playing.]

Gambling is social and competitive. There is always an opponent which affords gamblers the opportunity to raise their self esteem by bragging about their prowess in front of opponents and friends.

Gambling has a ritualistic quality. Each game is played within the context of specific rules. Gamblers write their own variations within a generally prescribed program.

The uncertainty and risk of the gambling event provide for the cognitive, emotional and physical arousal of the individual. This arousal and the belief that the gambling situation is safe (free from social punishments or failures)

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leaves the gambler in a comfortable state. This state can be described in terms of mood, a high or a mystic state. The state changes from passivity to wagers to cognitive emotional reactions to hopefully luckier actions. The self regulated playing, the safety and the fantasy is an important feature of gambling. Gambling is functional play activity.

A wager is a play. Through play, gamblers confirm their existence and affirm their worth. This theory is based on seven existential concepts to confirmation of existence and affirmation of worth: autonomy, freedom, desire, choice, action, responsibility, and identity.

From birth we have desire to grow psychologically. Growth takes form in the process of self discovery. We become aware at a very early age that the most pleasant kinds of self discoveries result from <u>autonomous</u> action. We feel most profound when we are responsible for the feeling. In order to be autonomous, we need <u>freedom</u> to act. Freedom can only be attained by taking absolute responsibility for one's actions. One becomes the sole creator of one's essence, ones's self, one's identity.

Central to the idea of action is <u>choice</u>. It is in the process of choosing a course of action that the authentic creation of the self occurs. The nature of choice is determined by our present, incomplete, always fulfillment seeking self.

Gamblers choose the game they <u>desire</u>. They also choose

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the manner of participation. Style of participation becomes an expression of present self. Participatory actions become a search for true self, essence or identity. Gamblers take responsibility for the outcome, (wins and loses), that their actions produce by staking hard earned money. The freedom for self regulation or identity of involvement provides for self expression and self stimulation. These, together with the responsibility already taken for actions lead to feelings of effectiveness, mastery, and worth. Gamblers prove to themselves they are alive by speeding up heartbeat, increasing muscle tension and becoming emotionally aroused with either hope or anxiety.

Phonemenological accounts explain five moods that emerge as participation in gambling increases: risk taking, here and now, fantasy, euphoria, and mysticism.

First the person must have a willingness to take risks. Once involved, the risk taking must be defined as pleasurable. The second mood is a heightened awareness of the player's existence. The mind concentrates on the immediate situation, without interference of memories from past or thoughts of the future; the here and now realization. The third mood fantasy, is experienced as deeper involvement in gambling is possible. With deeper involvement, part of the mind ironically, becomes free to do other things. As gambling becomes a medium for identity fantasizing, total commitment to gambling becomes possible.

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The fourth mood, euphoria is rare and often short lived. It occurs during highly condensed moments such as cashing in on a long shot, or winning after a calculated bluff at poker. Building an identity around euphoria is compelling. Fantasy and euphoria are experienced as the person passes from occasional to regular gambling. As the commitment to gambling develops, activities take on a ritualistic meaning. Sacred rituals dramatize identity. With identity, money, good feelings in balance, the gambler becomes very serious about the enterprise and shifts into a mystic state. It is at this stage gambling can become pathological and almost irreversible. The gambling becomes compulsive if the gambler chooses to enhance pleasure rather than play the game in the usual way.

XI. Professional Gambling

Hayano (1984) presents a profile of the professional gambler. He reviews Morehead's (1950) sub types of professional gamblers called bankers, cheaters, compulsives, and percentage gamblers. The banker may be the owner or operator of a legal or illegal gambling establishment. The gambler can be viewed more like a business person rather than like a gambler. The cheater description has a similar problem. The cheater acquires money by thievery or collusion rather than skill.

The compulsive gambler is a perpetual loser and should not be grouped with professionals. However the percentage

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player is a skillful player, with a feel for the probabilities and odds either by innate aptitude or memorizing and calculating specific formulas.

A professional relies upon skill, knowledge and experience to win. They derive all or a significant part of their income from gambling activities. There are four sub types of the true professional.

A worker professional works on the side, but spends a large portion of their time gambling. Gambling is not a career, but more like a serious hobby rather than a necessary occupation.

The outside supported professional has a steady income stream from savings, investments, retirement funds or other sources. This category included retirees, housewives, and students.

The subsistence professional is a consistent winner, but a small one. The gambler wants to win enough to pay bills and have enough to gamble with the next day. There is little commitment to moving toward higher stakes or playing against tougher competition.

The career professional makes a social and psychological commitment to gambling as an occupation. Even when broke, career professionals do not seek work, but borrow to gamble. They enjoy gambles for high stakes, the casino and card room atmosphere, and the lavish attention that accompanies high rollers. The status or sub types of any professional gambler

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is not permanent. Players change their behavior over time and as games change. The image of the completely controlled, unemotional, totally economically motivated professional gambler who wins year after year is a serious distortion of the facts.

Professional gamblers do not play games of pure chance such as roulette, craps, keno, lotteries, or slot machines. The mathematical house edge makes it impossible to win consistently in the long-run. Professional gamblers play games that involve skill and chance such as blackjack, poker, and horse races which require the bettor to analyze past information and to predict the future. It is possible, however, not likely or easy, that a professional gambler could win on a regular basis.

Also, most professional gamblers live in areas where casinos, card rooms, tracks, are readily available.

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Chapter Four

Related Literature - Economic

There have been only a few empirical studies by economists of the effects of price on both the decision to gamble and the amount of money gambled. These include studies using time series from horse racing [Suits (1979) and Morgan and Vasche (1982)], and micro data pertaining to lotteries [Brenner and Brenner (1987)]. These studies present evidence which suggests that the use of the price (takeout rate) would produce some reduction in both the number of gamblers and the amount of money gambled.

These studies, however, have several shortcomings which this research hopes to address. All of the previous work on the demand for gambling has been done in a static setting, while the research described below models demand for gambling over time. Also, none of the previous research formally models gambling as an addictive behavior and, as a result, the empirical estimation of the demand for gambling does not attempt to account for the dependence of current gambling on the level of past gambling. If gamblers are myopic, they will not fully appreciate the effects of gambling on their future well being, nor will they realize the dependence of future gambling on the level of current gambling. This work will use the rational addiction of Becker and Murphy (1986), which is based on the assumption that gamblers are rational, or far sighted, implying that they are aware of and incorporate into

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their decision making process the future costs of gambling given the widespread dissemination of information on the negative consequences of compulsive gambling and regressivity of the taxation effects. This model assumes that gamblers are aware of the interdependence of past, current, and future gambling consumption.

I. Pari-mutuel Studies

Suits (1979) focuses on price elasticity of demand for gambling. He studies the demand for legal bookmaking establishments in Nevada. His study reveals price elasticities higher than unity. This suggests that the tax revenue generating potential of gambling is limited. The source of the high elasticity is the availability of illegal gambling establishments and the ability to shift from legal to illegal gambling establishments in response to price changes.

Many gamblers consider gambling to be a recreational activity or a participation sport. Satisfaction is derived from the activity itself and the strings of wins and loses rather than from the ultimate outcome, the net amount won or loss. Gamblers are aware that they will lose on average and view the amount lost as the price of playing in the game. The object is not to get rich, but to have fun, or excitement. Gamblers view payment (which may be in the form of losses) for this recreation in the same way they view outlays on other forms of entertainment.

The expected loss from gambling is a result of

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establishments paying out less in winnings than the total number of dollars bet. The amount extracted is the takeout rate.

In pari-mutuel betting, takeout rates are set independently of the actual probability of winning, usually by statute. Bets are collected, takeout is subtracted from the total, the remainder is paid out to the winners according to an established formula. Takeout rates vary among games. Rates are low at casino games which are related to the probability of winning. In 1987, at pari-mutuel tracks, takeout rates ranged from 15% to 20% for win, place or show bets and from 17% to 36% for multiple horse or race wagers. State lotteries have a very high takeout rate, usually about 50% of the total amount bet. Takeout rates are the price of playing the game.

Betting establishments act as an intermediary among individuals who want to enter into certain relationships with each other, namely wagering. The total output (volume of service rendered) Q is the handle or total volume of wagers. P is the takeout rate or price per unit bet. P*Q is the revenue to the betting establishment.

For any given handle and takeout rate, a demand function can be constructed. However the demand schedule will represent a single game only. Nothing is said about handle expected from a lottery with 50% takeout and its substitutability with a race track with a 15% takeout.

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Different games are different products and are not close substitutes in minds of the players.

Suits studies the demand for bookmaking, which is legal in Nevada. The Federal excise tax on bookmaking was reduced from 10% to 2% at the end of 1974. While the tax rate was 10% bookmakers charged $2.20 for a $2.00 bet and paid winners at track odds. Tracks had 16% takeout rate. For a $2.00 bet, 32 cents were kept by the tracks. Therefore, bookmakers kept $0.52 from each $2.20 wager and had a 23.6% takeout rate in total.

After the tax rate reduction bookmakers absorbed the 2% and continued to pay at track odds. This made the new effective takeout rate 16%. Suits reports (p. 158) that the betting volume rose to over $9.5 million per quarter. A constant elasticity curve was fitted and a demand elasticity of -1.64 was derived.

Suits also estimated the demand for sports betting in a similar fashion. The reduction of the tax lowered the takeout rate from 18 to 10%. The demand elasticity was estimated to be -2.17. It has been conjectured that the substantial rise in the legal handle in Nevada was not due to the creation of additional wagering but that it was due to the attraction of bets to legal firms which were formerly placed with illegal operations.

Suits uses a moving cross section to estimate the elasticity of demand for pari-mutuel betting. His regression

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equation is:

(1) $Q_{it} = b_0 + b_1 Y_{it} + b_2 d_{it} + b_3 P_{it} + u_{it}$

where:

Q_{it} is the real handle at thoroughbred tracks in state i during year t divided by the population of the state. This represents the Per Capita Handle. Y_{it} is the real per capita personal income in state i. d_{it} is the number of days on the racing schedule or $d*_{it}$ which is the number of days divided by the state population. P_{it} is the pari-mutuel takeout rate in state i in year t. A dummy variable $D_{it,}$ is added to the model. It takes the value of 1 if the state is Rhode Island, West Virginia or Delaware, because these states are small; and 0 otherwise. This dummy variable assumes that Q_{it} contains bets placed by visitors to these states. Regressions were fitted for 24 states that offered thoroughbred racing for the period 1949-1971. Table 4-1 shows the results.

Table 4-1
Estimation of Suits' Three Models

Model	(1)	(2)	(3)
Intercept	64.16	59.80	37.45
Y_{it}	.0116	.0128	.0106
	(.0015)	(.0016)	(.0009)
d_{it}	.0093		
	(.0118)		
d^*_{it}		.3350	.1340
		(.016)	(.018)
P_{it}	-447.5	-572.4	-333.8
	(72.2)	(55.0)	(47.7)
D_{it}			56.61
			(1.87)
R^2	.12	.49	.81

figures in parentheses are standard errors.

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Table 4-2

Elasticity Ranges from Suits' Estimation

Model	Income	Price	# Racing Days
1	.95 ± .12	-2.14 ± .35	.046 ±.058
2	1.05 ± .13	-2.73 ± .26	.069 ±.003
3	.86 ± .07	-1.59 ± .23	.027 ±.004

The state is in a position to set monopoly prices on and extract monopoly rent from racing operations. The state sets the racing season for each track and establishes the takeout rate for each of the several tracks operating under state supervision. The state also fixes the division of the resulting revenues between track operators and the state. In order to maximize state tax revenues, the state should establish a takeout rate high enough to maximize profits but set the track's share high enough to assure continued operation. Suits sets the track cost function as a function of handle.

$$(2) \quad R = PQ - C(Q)$$

where $C(Q)$ is the track operating cost. Revenue is maximized when:

$$(3) \quad P = [C'(Q)\, e]/(1+e)$$

where e is the demand elasticity and $C'(Q) = MC$. This is the usual monopoly pricing formula.

Maximum state revenue would be derived by setting the takeout rate as defined above but allowing only a fraction $C(Q)/Q$ of handle to be retained by track operators. The

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remaining P-C(Q)/Q would be the pari-mutuel tax as a percentage of handle and would accrue to the state as revenue. Takeout rates and their division between the state and track operators must be legislated for some period of years ahead. The pricing formula must be set in terms of operating costs at expected future operating rates.

Therefore, refinements in the pricing formula must give way to approximations more suitable to the practical application of the problem. Suits uses (p. 161) the average cost, k, at some given operating rate or the track share of the handle. Once k is fixed, the price can be set to maximize revenue to the state.

(4) $P = ke/(1 + e)$

is the most profitable price. Suits' results show that the average pari-mutuel to track is 7%. Table 4-3 shows the calculated maximum takeout rate by inserting this equation into models 1, 2, and 3 from above.

Table 4-3

Maximum Takeout Rate From Suits' Estimation

Model	P % of handle	Range
1	13	11.7-15.9
2	11	10.5-11.6
3	18.9	15.5-26.4

All compare well with mean takeout of 14.3% observed in the data. The observed mean takeout exceeds models 1 and 2

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but falls short of model 3 which embodies the most reliable estimate. This suggests that the takeout rates actually legislated by these two states have fallen short of levels that would maximize state revenue.

W. Douglas Morgan and Jon David Vasche (1982) challenge an article by Pescatrice (1980) which concluded that the demand for pari-mutuel wagering is relatively inelastic with respect to changes in the price of wagering. Pescatrice then suggested that governments seeking to increase pari-mutuel revenue receipts should raise the price or tax rate on wagering.

Morgan and Vasche study the California pari-mutuel industry and conclude that (p. 469) demand is elastic with respect to price. They estimated demand coefficients used to explain the strong response in California to a recent law reducing the price of wagering. Because pari-mutuel attendance is inversely related to the price of wagering, Pescatrice's specification for pari-mutuel racing produces downward-biased estimates of price elasticity. If corrected for this bias, Pescatrice's analysis would suggest an elastic demand for wagering.

The policy implication here is that if governments attempt to increase pari-mutuel tax revenues by raising takeout rates, (as Pescatrice shows) revenues will actually fall. Morgan & Vasche suggest that state governments should lower takeout rates. Using their previous work Wagering Per

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Attendance and Attendance Per Capita are used as dependent variables. Other variables include real disposable personal income, unemployment rates, takeout rates, availability of horse racing substitutes (Harness, Quarter Horse racing days) and dummy variables for years and special characteristics of the time period.

Table 4-4
Results from Morgan and Vasche Estimation

	Intercept	Income	Days	Price	Unemp	Harness Days
Per Capita Attendance $R^2 = .985$	.234	$-.295(10^{-5})$	.00081	.812	.142	$.56(10^{-4})$
Wagering Per Attendance $R^2 = .962$	-96.070	.042	.728	-21.78	-113.9	.010

The attendance variable is significantly related to price but not the average wager variable, therefore they conclude that changing the takeout rate does not change the average wager per attendee. Once present at a race track bettors follow constant betting patterns.

Guthrie (1981) responds to the Morgan and Vasche (1979) analysis of demand functions for horse race gambling. Morgan and Vasche concluded that California could increase revenue to the state by lowering the price of gambling (the takeout rate). The price reduction would cause more than a proportionate increase in attendance at tracks which would in turn increase the aggregate amount bet and tax revenues for the state. Guthrie suggests that the Morgan and Vasche

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analysis overstates the tax revenue potential of horse race gambling. He proposes that California has already priced horse racing bets at a level that nearly maximizes the revenue to the state and that changing the takeout rate will not have a substantial effect on state tax revenues. He states that the changes would just be a fine tuning process which would result in only a small change in revenue. Morgan and Vasche report an elastic relationship between the takeout rate and attendance per capita, with a coefficient of -1.48. This would suggest that revenues are not at their maximum. Guthrie concludes that only very restrictive assumptions would yield these results.

Guthrie's Model

If TR is the total revenue to the firm, TH is the total handle, and t is the takeout rate, which is split between the state and the track. If x is the proportion of TR that goes to the state, (1 - x) is the proportion of TR that is retained by the firm. Then TR is xTR + (1 - x)TR and TR is SR + (1-x)TR where SR is the state tax revenue. In order for the state to maximize tax revenue, it must retain a large proportion, leaving a small proportion for the track. However no track would continue operation unless it covers the opportunity cost of production [however as Guthrie notes, tracks may receive less than the opportunity cost in the short-run given that the optimal quantity was above the shutdown point]. If total cost is equal to TC = (1 - x) TR

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then SR is equal to TR - TC. This shows that the state's revenue function is the same as the firm's total profit function. Therefore the state maximizing revenue is the same as the firm maximizing profits. This suggests that the state must set the takeout rate at the level that will maximize the firm's profits and not at the level that maximizes revenues for the firm. Guthrie states that the Morgan and Vasche's recommendation of setting the takeout rate at a level that would yield a price elasticity of -1, is essentially setting marginal revenue equal to zero. This would need the condition of marginal costs equalling zero in order to be the maximizing price. Morgan and Vasche list the marginal costs to include the costs of increasing state regulation, enforcement and licensing activities and consider these minor. Guthrie suggests that Morgan and Vasche do not consider variable costs associated to race tracks which increase as output increases such as labor (which he says alone justifies the existence of positive marginal costs). This would then show that if MC is positive and MR = MC at the level of output, the firm is operative in the elastic portion of the demand function. The result is that of a monopoly firm with a downward sloping demand curve. Tracks are essentially monopolies since only one track is licensed to operate in an area at a specific time.

However, if the state is a tax revenue maximizer, then the state is the monopolist and the firm is a competitively

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paid agent. The maximum state revenues are equal to the entire monopoly profits of the firm.

Marginal cost can be calculated using P = MCe/(1 + e) where P is price and e is elasticity. If P = .179 and e = -1.48 then marginal cost equals .058 which is greater than zero. These (Morgan and Vasche) results are in agreement with the monopoly model. This suggests that profit maximizing behavior exists in the horse racing industry, and Morgan and Vasche's conclusion that the potential for increased state revenues appears to exist overstates the situation and is not warranted on the basis of the calculated demand function.

Guthrie suggests that to raise tax revenues the industry should be restructured. More racing days, more tracks, more than one race track operating at a time, and different admission charges are suggested changes.

Morgan and Vasche (1981) respond to Guthrie's (1981) analysis of their paper. They defend the fact that in the context of their original study (1979) that no additional costs are incurred if more patrons attend existing racing meets and therefore there is not evidence of positive marginal costs.

Also they claim that even if marginal costs did rise, that marginal revenues from pari-mutuel revenues must also be positive is not a necessary condition. This is because of the existence of non pari-mutuel receipts (admission fees, programs, concessions, parking), which were omitted from

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Guthrie's analysis. These receipts are reported to be approximately 40 percent of income (in an analysis of the California Horse Racing industry cited by the paper).

These non pari-mutuel revenues are not shared with the state. This, they suggest, means that the state can maximize its revenue by setting a takeout rate where marginal pari-mutuel wagering revenues equal zero.

At the same time firms can experience positive marginal costs offset by positive marginal revenues. Their study showed that total marginal revenues per attendee can rise faster than the marginal cost per attendee when attendance rises, thereby increasing profitability. They conclude that there is no inconsistency between the criteria that they used for state revenue maximization and the standard criteria for firm profit maximization for racing associations even when marginal costs are positive. They continue to believe that reducing the takeout rate has the potential to increase state revenues.

II. Efficiency Studies

Several studies look at the efficiency of betting markets. Ali (1977), (1979), Asch, Malkiel, and Quandt (1982), (1984), and Quandt (1986) do studies of the profitability of betting on a particular horse in an efficient sense. The profitability depends on the objective factors concerning the horse such as the horse's ability, track conditions, the jockey's skill or the qualities of the other

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horses in the race. The profitability is also affected by subjective factors such as the bettor's opinions of the horse and therefore by the amount bet on the horse. Therefore, betting is very similar to investing.

Quandt reports that when subjective and objective probabilities are similar, favorites tend to be underbet and long shots tend to be overbet (p. 201). He concludes that this is consistent with the fact that equilibrium is required and that bettors are risk loving.

Snyder (1978) shows that there are similarities between securities markets and horse betting markets and suggested applying the theory of efficient markets to the horse betting market. He provides a useful basis for the formulation of a test for market efficiency. Also, he looks at how handicapper's quoted odds influence publicly determined odds. He finds a negative relationship in horse betting between the expected rate of return and risk. This contrasts capital market theory which assumes that buyers require a higher rate of return for assuming greater risk (p. 1112). He states that the cause of the bias is clear. Bettors create an overlay by betting a smaller proportion on lower odds horses than their actual chances of winning justify. The cause is clear but the reason for the bias are not. The bias could be a reconfirmation of the general tendency for all bettors to prefer low probability-high prize combinations over high probability-low prize combinations. So the important

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psychological variable is subjective probability. Bettors behave as if they possess a utility function for money which demonstrates an increasing marginal utility for money. Every bet includes a potential monetary gain and utility derived from other factors involved in making a bet such as handicapping, pitting one's predictions against other and elements of luck (p. 1113). He says that a main reward of horse betting is the thrill of successfully detecting a long odds winner thereby confirming the ability to outperform others. He concludes that the public has a clear and strong bias which substantially affects the rate of return for various odds groups but that bias is not large enough to overcome the track takeout rates. He also suggests a stronger test. There are knowledgeable insiders in the horse betting market who may be able to profit from their position. The predictions of these insiders are available to the public in publications such as The Daily Racing Form, through daily newspapers and through horse racing officials. He observes that the experts odds diverged more from an unbiased prediction than the general betting public's pari-mutuel odds did. The experts' rates of return are larger at low odds and smaller at high odds than the publics' rate of return. He feels that this may because experts are attempting to predict the odds that the public will create rather than predicting each horse's actual winning chances. He concludes that there are statistically significant differences between the

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subjective and empirical probabilities of winning for particular odds-groups of horses. However, these differences are not large enough to exceed the price of betting, the takeout rate. Other studies presenting similar results on efficiency are Dowie (1976), Gruen (1976), Hausch, Ziemba, and Rubinstein (1981), and Crafts (1985).

Losey and Talbott (1980) attempt to clarify the applicability of the efficient markets model to pari-mutuel betting markets. They implement a test by making hypothetical bets on horses listed in The Daily Racing Form at odds of 3 to 1 or less which actually go off at longer odds than those reported. These overlays should yield above average returns because they are underbet in public wagering relative to their actual chances. The measure of the extent of the divergence of the handicapper's odds from publicly determined odds is the overlay ratio. It is obtained by dividing the final pari-mutuel odds by the handicapper's odds. Higher values of the overlay ratio should indicate higher expected returns for the bets. However, they find that bets on horses with higher overlay ratios yield higher losses, contradicting expectations. They accept Snyder's absence of profit potential in pari-mutuel betting markets and conclude that there is insufficient evidence to indicate pari-mutuel markets are inefficient.

Amoaku-Adu, Marmer, and Yagil (1985) tested the efficiency of the football betting market. In an efficient

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market, new information should be automatically reflected in prices and all opportunities for profit by systematic betting patterns should be eliminated. They tested three hypotheses: Closing spreads provide good estimates of the expected differences in points scored between teams; the expected rate of return for bets in all types of closing spreads should be equal; and, a mechanical betting system using opening or closing spreads should not yield excessive profits.

The results showed that the football betting market is not perfectly efficient. Specifically, there is little connection between closing spreads and actual game outcomes. The rates of return spreads are not equal, and abnormal returns can be earned by betting either the opening or closing spread using technical strategies.

Gamblers betting long shots are rational individuals attempting to maximize returns. Significant factors in determining closer spreads are: favorite won last game, bookie's shift of the line, favorite at home, average total yards gained per pass attempt on offense, average total yards given up per point on defense and average yards gained per pass attempt on offense.

III. Off Track Betting Pari-mutuel Studies

Coate and Ross (1974) examine the effect of the introduction of off track betting in New York on handle and attendance at New York City area tracks. They also examine whether the state government was losing revenues because of

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the presence of off track betting and if the revenue received by New York City from the Off Track Betting Corporation has come at the expense of the state government and the racing industry.

In 1970, New York state established off track betting to provide local governments with additional revenue and to reduce the amount of illegal gambling in the state. This broke the state's monopoly on tax revenues from legal horse race gambling and enabled local governments to enter the market. The takeout rate was established at 17% with the state receiving 1.2% and the race industry receiving 1.5%. This contrasts with the 10% that goes to the state and the 7% that goes to the tracks for bets placed at the tracks. Local governments would gain revenues at the expense of the industry and the state government. New York City was the first area to institute off track betting. During the first year of existence, substantial decreases in handle and attendance occurred at New York City tracks. These declines had adverse effects on pari-mutuel revenues to the state even after including payments to the state from the Off Track Betting Corporation. A moratorium was declared in 1972 on the establishment of any new off track betting sites. Others argued that the slowdown in the national economy, poor weather and the increase in the takeout rate from 16% to 17% were responsible for the losses in attendance and handle at New York City area tracks.

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Coate and Ross run two multivariate regressions: Average daily attendance at thoroughbred tracks as a function of the day of the week, temperature, precipitation, season, off track betting activity, economic prosperity, professional team sports and a time trend; and, daily pari-mutuel handle at thoroughbred tracks as a function of the day of the week, temperature, precipitation, season, off track betting activity, economic prosperity, professional team sports and a time trend.

The results show that the introduction of off track betting caused a decline in average daily attendance of 4750 people or a total of 1.6 million people (4750 times 337 days) at thoroughbred tracks. There was also a decline in the daily handle at thoroughbred tracks of $440,000 or a total of $148.3 million ($440,000 times 337 days) and a decline at harness tracks of $103,000 or a total of $53 million ($103,000 times 337 days). The introduction of off track betting resulted in a loss of $201.3 million in New York City area tracks. The state lost $22.9 million in revenues because of the decline in handle (the state received 11% at thoroughbred and 12.5% at harness tracks). The state also lost $1.1 million in admission tax revenues. The gross revenue loss to the state was $24 million. Netting out the revenues that the state received from the Off Track Betting Corporation, which were $10.5 million, the net state revenue loss was $13.5 million.

New York City received payments of $17.5 million from the

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Off Track Betting Corporation. However, the city lost $1 million in admission tax revenue. New York city net revenues from off track betting was $16.5 million ($3 million greater than the state revenue loss).

The decrease in the handle resulted in a $12.8 million loss to the horse racing industry (7% share of thoroughbred and 4.5% share of harness handles). The local tracks also lost concessions, parking and admissions revenues of $6.5 million. Therefore, the gross local racing industry lost $19.3 million. The off track betting payments to the local industry were $11.2 million which makes the net revenue loss $8.1 million.

IV. Pari-mutuel and Lottery Studies

Gurley (1987) examines whether the implementation of a lottery affects the average daily pari-mutuel handle and if so, the direction of the effect over time. Average daily handle, attendance and per capita wagers were examined for thoroughbred race meets in states where lotteries were instituted during the 1970's and 1980's. Paired t-tests were used to analyze the year the lottery was put in place and for two years prior and for two years following the lottery.

The study shows no significant differences in average daily handle from two years before the lottery to one year before the lottery. There was a small but not statistically significant decrease in the average daily handle in the year of the lottery from both one and two years before the lottery.

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Large and significant decreases in the average daily handle in the year following the lottery from both one and two years before the lottery were found. Large and significant decreases in average daily handle two years after the lottery from the lottery year and both one and two years before the lottery were found as well. The study found a small but not statistically significant decrease in average daily handle two years after the lottery from one year after the lottery.

Similar patterns were observed for average daily attendance, however, with large and significant decreases beginning the year of the lottery and continuing through the second year following it. There were increases in per capita wagers through the time period explained as the loss of the small marginal bettors from the tracks while larger bettors continued to attend.

Gulley and Scott (1989a), (1989b) analyze the relationship between lotteries and thoroughbred horse racing using regression. Their results indicate that an additional dollar bet per capita on the state lottery leads to a decline of 18 to 32 cents in the typical track's average handle per patron. The existence of a lottery reduces attendance at tracks, however, whether this effect, measured by the lottery age, wears off over time is unclear. The time period for the study is 1976-1980 for sixty one United States tracks.

The study focuses on race track attendance and on the average handle per patron. Race track attendance is reported

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to be an inferior good and more appealing to older people. The existence of other spectator sports or other gambling opportunities in the market reduces attendance. The market unemployment rate and the percentage of the market that is black have unclear effects on attendance.

Increases in the number of races reduces the average handle, a result consistent with profit maximizing behavior by tracks. Increases in the takeout rate have a negative effect on average handle with price elasticity estimates ranging from -.39 to -.46. Real per capita income and the percentage of the population that is black have positive effects of average handle.

V. <u>Lottery Studies</u>

Spiro (1974) mailed a questionnaire to 1250 winners of $100 or more in the Pennsylvania lottery. Respondents were asked to indicate their income and the number of tickets they purchased for the drawing in which they were winners. Three hundred responses were received. From these, 271 usable observations were analyzed. Spiro assumed that the ticket purchases are a linear function of income.

(5) $T = A + b\ Y$

where T is tickets and Y is income. Tax is progressive if the intercept A is negative and slope b is positive. If either condition is not met, the tax is regressive or proportional (since people in high income groups do not pay proportionately more in taxes than persons in low income groups).

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The results were:

$$(6)\quad T = \underset{(.76)}{1.875} + \underset{(.000055)}{.00016}\ Y$$

with an R^2 of .029 [standard errors in parentheses].

A second logarithmic version was tested with:

$$(7)\quad \ln T = \alpha + \beta \ln Y\ .$$

This version yields elasticity. If the slope β is less than one, the tax is regressive. The results were:

$$(8)\quad T = \underset{(.738)}{1.057} + \underset{(.08)}{.2169} \ln Y$$

with an R^2 of .023 [standard errors in parentheses].

Spiro concludes that the lottery tax is highly regressive for the subset of the population that won the lottery. He addresses the fact that the sample may not be random and that there may be a response bias. The lottery tax contributes to a greater inequality in income distribution than would have prevailed in the absence of the lottery.

Babbel and Staking (1983) found that the income elasticity of lottery spending was close to unity and was constant over all income levels. They conclude that 1% of income is spent on lotteries irrespective of income level. No estimate of price elasticity is made.

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Chapter Five

Theoretical Model of Gambling as Rational Addictive Behavior

The theoretical model being used to investigate gambling is based on Gary Becker and Kevin Murphy's (1986, 1988) model of rational addiction and incorporates elements of the models as implemented by Becker, Grossman and Murphy (1987) and Chaloupka (1988), (1990a), (1990b). The model is one of individuals maximizing lifetime utility subject to a lifetime budget constraint and various production functions in a continuous time framework. At any moment in time, the individual's utility is a function of three factors W(t), L(t) and Z(t).

(1) $U(t) = u[W(t), L(t), Z(t)]$

W(t) is the individual's stock of wealth at time t , L(t) is the individual's stock of leisure at time t, and Z(t) is a vector of consumption goods. The utility function, u, is assumed to be a concave function with negative second derivatives with respect to each of the arguments.

(2) $U_i(t) > 0$

where i= W(t), L(t), Z(t).

(3) $U_{ii}(t) < 0$

where i= W(t), L(t), Z(t).

The arguments in the utility function are produced according to the following functions:

(4) $W(t) = W[F(t), G(t)]$

where:

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(5) $W_F(t) > 0$, $W_{FF}(t) < 0$, $W_G(t) < 0$, $W_{GG}(t) < 0$.

Wealth at time t, W(t), is assumed to be a function of a vector of financial market goods such as savings, bonds, stocks, and the individual's flow of income, which enters into the production of wealth, are grouped together and called F(t). These inputs are assumed to have a positive but diminishing effects on wealth.

The second argument in the wealth function is the level of the addictive stock at time t, G(t). The stock is an attempt to capture the dependence of current utility on the past consumption of gambling. It is assumed that the greater the level of the gambling stock (the larger the degree of addiction), the lower the level of wealth, ceteris paribus. This is a reasonable assumption given all the mathematical odds demonstrating the impossibility of continual winning on any form of commercial gambling. Also, the assumption is made that the wealth effects of the stock become decreasingly negative as the stock increases ($W_{GG} < 0$). The hypothesis is that these assumptions partially incorporate the notion of physical dependence on gambling resulting in withdrawal-like symptoms when consumption is terminated. This is one of the characteristics that distinguishes the consumption of an addictive good from the consumption of other goods since the negative wealth benefits of the stock of past consumption are not offset by the positive utility derived from current consumption.

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(6) $L(t) = L[B(t), G(t)]$

where:

(7) $L_B(t) > 0$, $L_{BB}(t) < 0$, $L_G(t) < 0$, $L_{GG}(t) < 0$, $L_{BG}(t) > 0$.

This argument is the instantaneous utility function is the level of leisure produced by the consumption of the addictive good, bets represented by B(t). Leisure here can be thought of as the physiological and psychological effects which result from the consumption of gambling. Increased consumption of gambling is assumed to have a positive effect on the production of leisure. On the other hand, greater past consumption which results in a larger stock of gambling is assumed to have a negative effect on the production of leisure. This assumption is made to incorporate the notion of tolerance into the model, the second of the factors distinguishing addictive consumption from the consumption of ordinary goods. An acquired tolerance in gambling implies that the gambler gets less satisfaction from gambling or placing the same number of bets as in the past or alternatively, a greater number of bets must be placed to achieve the same level of satisfaction as in the past. The acquired tolerance in the case of gambling is not characterized, however, by continuously escalating consumption, as in the case of (some) other addictive goods. Evidence of this is the eventual maintenance of gambling consumption at some plateau level, leading to the assumption of $L_{GG} > 0$. To capture the final factor which differentiates

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addictive consumption from the consumption of other goods, the assumption is made that the effect of consumption of gambling at time t on the production of leisure is larger, the larger is the level of the gambling stock at time t . This assumption illustrates the notion of reinforcement in the consumption of gambling. People who gambled more in the past will have a better understanding of the ways in which gambling can, for example, alleviate traumatic life situations and stress and therefore be more efficient producing leisure.

(8) $Z(t) = Z[X(t)]$

where:

(9) $Z_x > 0$, and $Z_{xx} < 0$.

The vector of consumption goods, Z(t), is produced using inputs X(t), which include market goods and the individual's own time. All inputs are assumed to have a positive but diminishing marginal productivity in the production of Z. The implicit assumption has been made that the consumption of gambling has no direct effect on the individual's ability to produce Z. The production of Z could be modelled as a function of the gambling stock also under the assumption that as the level of the gambling stock rises, the person becomes less efficient in the production of consumption commodities. However, the effects of the stock are more relevant in the production of wealth and leisure that little additional insight would be gained by including the stock of gambling in the production of Z.

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Based on the assumptions above, the instantaneous utility function can be rewritten as:

(10) $U(t) = U[B(t), G(t), N(t)]$

where B and G are as above, and N(t) is a vector which includes all market goods which are inputs into the production of consumption goods and wealth, as well as the individuals own time in their production. At any time t, the following will be true:

(11) $U_B = u_L L_B > 0$

(12) $U_G = u_L L_G + u_W W_G < 0$

(13) $U_N = u_N W_N + u_Z Z_N > 0$

(14) $U_{BG} = u_{LL} L_C L_G + u_L L_{CG} > 0$

and:

(15) $U_{ii} = < 0 \quad i = B, G, N$

Reconsidering the factors which must exist for an activity to be addictive: tolerance, reinforcement, and withdrawal, equations (11)-(14) can be used to illustrate each. Equation (11) can be thought of as incorporating withdrawal since it implies that total utility will lower if consumption is reduced. Tolerance is illustrated by the negative marginal utility of the gambling stock shown in (12), which states that the greater the level of past consumption, the lower the level of utility, ceteris paribus. Finally, reinforcement is illustrated by (14) which states that the marginal utility of current consumption is larger the larger the level of past consumption, and that past consumption

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reinforces current consumption.

The process by which the stock of gambling is accumulating follows Becker and Murphy's simple investment function specified as:

(16) $\dot{G}(t) = B(t) - \delta G(t) - g[E(t)]$

C(t) is the consumption of gambling betting at time t, which can be thought of as the gross investment in the gambling at time t, G(t), the level of the gambling stock at time t. δ is the constant rate of depreciation of the gambling stock over time. Finally, g[E(t)] is the endogenous depreciation of gambling at time t. Endogenous depreciation includes any attempts the individual makes to stop gambling such as Gambler's Anonymous or seeking professional psychological or other medical help. Endogenous depreciation attempts are assumed to have no direct effect on the utility of the person.

This function can be integrated over time to find the level of the stock at time t, which is given by:

(17) $G(t) = G(0)\, e^{-\delta t} + \int_0^t \{B(\tau) - g[E(\tau)]\} e^{-\delta(t-\tau)}\, d\tau$

where G(O) is the initial level of the gambling stock.

Assuming that the utility function is additive over time and that the individual has a constant rate of time preference, σ, the lifetime utility function is:

(18) $U = \int_0^\infty e^{-\sigma t}\, u[B(t), G(t), N(t)]\, dt.$

Making the assumption, following Becker and Murphy, that the gambler behaves rationally implies that this function is

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maximized subject to a lifetime budget constraint. If the individual's allocation of time over the life cycle is ignored, N(t) is treated as a composite good whose price $P_N(t)$ is the numeraire, and perfect capital markets are assumed, this budget constraint is:

$$(19) \quad \int_0^{\infty} e^{-rt} [N(t) + P_B(t)B(t) + P_E(t)E(t)]\, dt \leq D(0).$$

$P_B(t)$ is the price of the addictive good, bets, at time t, $P_E(t)$ is the price of the endogenous depreciation attempts, r is the market interest rate at which the individual can borrow or save, assumed constant over time and D(0) is the discounted value of lifetime income and assets.

Maximizing lifetime utility subject to the budget constraint, the stock accumulation function, and the initial stock condition above yields an optimal path as the solution to:

$$(20) \quad V^*[D(0),G(0),P] = \mu D(0) + \max_{BN}\Big\{ \int_0^{T} e^{-\sigma t} u[B(t),G(t),N(t)]dt - \mu \int_0^{\infty} e^{-rt} [N(t)+P_B(t)B(t) + P_E(t)E(t)]\, dt \Big\}.$$

V*[.] is the value of the solution in utility terms given the person's discounted lifetime income, initial level assets, and the prices faced over the lifetime represented by P. μ is defined as $\delta V^*[.] / \delta D(0)$.

The optimal paths for the consumption of gambling, the composite good, and any endogenous depreciation attempts can be determined by the following first order conditions:

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(21) $U_W(t) = \mu e^{-(\sigma-r)t}$

(22) $U_B(t) = \mu \; \pi_B \; (t)$

and:

(23) $S_E(t)g(t) = \mu \; P_E(t) \; e^{(\sigma-r)t}$

where:

(24) $\pi_B \; (t) = P_B(t) \; e^{-(\sigma-r)t} + g(t)$

and:

(25) $g(t) = -\int_0^T e^{-(\sigma+\delta)(\tau-t)} U_G \; (r) \; d\tau$.

$\pi_B(t)$ can be thought of as the full price of gambling and consists of two parts: the money price $P_B(t)$ appropriately discounted, and the discounted utility cost of additional consumption through the effects of the increased gambling stock on future utility, g(t), the shadow price of additional unit of the gambling stock [derivation from Becker and Murphy (1986)].

The first order condition for the consumption of gambling at any time t illustrates the two effects on utility of a change in the market price of bets at time t. The first effect consists of the change in utility at time t as a result of the change in consumption at time t induced by the change in price. However, a change in consumption at any time will affect utility in all future periods through the change in all future levels of the gambling stock. The first effect is given as:

(26) $e^{-\sigma t} \; U_C(t) - \mu \; e^{-rt} P_C(t)$,

and the second is:

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$$(27) \quad \int_t^{\infty} e^{-\sigma t} U_A(\tau)[\delta A(\tau)/\delta C(t)]\, \delta\tau,$$

where:

$$(28) \quad [\delta A(\tau)/\delta C(t)] = e^{-\delta(\tau - t)} .$$

Utility maximization implies that the sum of these two effects will be zero at each time t, which, after the appropriate simplifications and the above substitutions, yields equation (22).

Similarly, a change in the price of endogenous depreciation efforts will impact utility in all future periods through its effect on the level of the gambling stock in all future periods, as described by equation (23).

Since $u_G(t)$ is negative at all t, the full price of the consumption of gambling will be larger than its money price. It is also clear that the shadow price of the gambling stock will be affected by both the exogenous rate of depreciation on the stock, δ, and by the rate of time preference, σ, ceteris paribus. The larger the rate of depreciation, the lower the shadow price of the stock, resulting in an increase in consumption. Similarly, the greater the rate of time preference, the lower the full price of the addictive good, bets, and therefore its consumption. The shadow price of the gambling stock is rising as the level of the stock increases, since $U_{GG} < 0$.

Because of the rising shadow price of the addictive stock becomes larger, the amount of endogenous depreciation and the expenditures on endogenous depreciation will increase as the

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stock increases. They will also increase as the rate of time preference and/or the rate of exogenous depreciation decreases, ceteris paribus.

As the individual gets nearer to the end of life, the full price of gambling consumption falls as the result of the fall in the shadow price of the gambling stock. The shadow price is falling since the cumulative effect of consumption on future utility is decreasing, ceteris paribus. This may imply that older people will consume gambling more heavily than others and may be less responsive to changes in the money price of the addictive good.

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Chapter Six

Empirical Model of Gambling as a Rational Addictive Behavior

The estimation framework is derived from Becker and Murphy's (1986, 1988) model, Becker, Grossman and Murphy (1987), and Chaloupka (1988). A quadratic utility function in three arguments, N(t), B(t), and G(t), is assumed by Becker and Murphy in order to obtain linear first order conditions at each time t. In addition, endogenous depreciation, E(t) is assumed to be zero, and the rate of time preference (σ) is assumed to be equal to the market rate of interest (r), or σ=r. Based on these assumptions, the instantaneous utility function is:

$$(1)\quad U(t) = a_N N(t) + a_B B(t) + a_G G(t) + (U_{NN}/2)[N(t)]^2 + (U_{BB}/2)[B(t)]^2 + (U_{GG}/2)[G(t)]^2 + U_{NG}[N(t)G(t)] + U_{BG}[B(t)G(t)] + U_{NB}(N(t)B(t)].$$

Lifetime maximization of this utility function subject to the following budget constraint:

$$(2)\quad \int_0^\infty e^{-\sigma t}[N(t) + P_B(t)B(t)]\,dt \le R(0)$$

implies that the optimal consumption paths are yielded as the solution to:

$$(3)\quad V^*[D(O),G(0),P] =$$

$$\mu\, D(0) + \underset{BN}{Max}\, [\int_0^\infty e^{-\sigma t}\{U(t) - \mu[N(t) + P_B(t)B(t)]\}\,dt]$$

subject to the stock accumulation equation:

$$(4)\quad \dot{G}(t) = B(t) - \delta G(t)$$

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and the initial condition $G(0) = G_0$, where the marginal utility of wealth, μ, is defined as $\mu = \delta V^*[\cdot]/\delta D(0)$, and is constant over time.

Using the first order condition for N(t) the following substitution can be made for N(t) at each point in time:

$$(5) \quad N(t) = 1/U_{NN} \, [\mu - a_N - U_{NG}G(t) - U_{NB}B(t)] \; .$$

Making this substitution results in the maximization problem being a function of only betting consumption and the stock of past betting, or:

$$(6) \quad V^*[.] = K + \underset{B}{\text{Max}} \, \{ \int_0^{\infty} e^{-\sigma t} L[B(t), G(t)] \, dt \}$$

where:

$$(7) \quad L[B(t),G(t)] = a_G G(t) + a_B B(t) + (a_{GG}/2)[G(t)]^2 + (\alpha_{BB}/2)[B(t)]^2 + \alpha_{BG}B(t)G(t) - \mu P_B B(t) \; ,$$

and:

$$(8) \quad K = \mu D_0 + [(\mu - \alpha_N)^2 / 2\sigma U_{NN}][1-(1/e^{\sigma t})]$$

where:

$$(9) \quad \alpha_G = a_G - (U_{GN}/ U_{NN}][b_N - \mu]$$

$$(10) \quad \alpha_B = a_B - (U_{BN}/ U_{NN}][b_N - \mu]$$

$$(11) \quad \alpha_{GG} = U_{GG} - U_{GN}{}^2 / U_{NN}$$

$$(12) \quad \alpha_{BB} = U_{BB} - U_{BN}{}^2 / U_{NN}$$

and:

$$(13) \quad \alpha_{BG} = u_{BG} - U_{BN} U_{GN} / U_{NN}.$$

The function in (6) is being maximized subject to the stock accumulation process described by (4) as well as the following transversality condition:

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(14) $\lim_{t\to\infty} e^{-\sigma t} G(t)^2 = 0$.

Given the specification of the stock accumulation process in equation (4), B(t) can be replaced by $\delta G(t)/\delta t + \delta G(t)$, making the maximization problem one involving only G(t) and $\delta G(t)/\delta t$. This maximization problem is now part of a class of economic problems known as control problems, where the control variable is B(t), the consumption of the addictive good (bets), the state variable is G(t), the accumulated stock of the addictive good, and the equation of motion is the stock accumulation equation given in (4). This class of problems can be solved using a variety of techniques including the Calculus of Variations and Optimal Control Theory. (see Frank's footnote p. 188).

As discussed by Becker and Murphy, (14) is the quadratic analog of the standard transversality condition which requires that the discounted value of the state variable (G(t)) multiplied by it's shadow price (given as g(t) (equation (22) in chapter 5) goes to zero as time goes to infinity.

Based on the modelling of addiction in Chapter 5, α_G is expected to be negative. This negative effect is the result of the negative marginal productivity of the addictive stock in the production of leisure, the acquired tolerance effect, as well as the result of the negative financial effects of gambling addiction. Similarly, α_B is expected to be positive due to the positive effect of gambling on the production of leisure, and therefore on utility.

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Both α_{GG} and α_{BB} are negative from the assumption of concavity. Assuming that the marginal utility of the of the composite good N is independent of the level of the addictive stock (U_{NG} = 0), implies that the marginal utility of consumption increases as the level of the addictive stock increases (α_{BG} > 0). This expectation is based on the modelling of the reinforcement factors in the consumption of addictive goods.

To get an empirically tractable demand equation for betting, the model is converted to a discrete time framework. In discrete time, the maximization process described by (6) is:

$$(15) \quad V^*[.] = K + \max_{B} \{ \Sigma_{t=0}^{\infty}(1+\sigma)^{-t} L[B(t),G(t)]\}$$

where t= 0,1,2,3...T and

$$(16) \quad G(t) = B(t-1) + (1-\delta)G(t-1).$$

A typical first order condition with respect to betting consumption for this maximization problem is:

$$(17) \quad \delta V^*[.]/\delta B(t) = [1/(1+\sigma)^{t}]*\{\delta L[B(t),G(t)]/\delta B(t)\} + [1/(1+\sigma)^{t+1}]*\{\delta L[B(t+1),G(t+1)]/\delta G(t+1)\}*\{\delta G(t+1)/\delta B(t)\} + [1/(1+\sigma)^{t+2}]*\{\delta L[B(t+2),G(t+2)]/\delta G(t+2)\}*\{\delta G(t+2)/\delta B(t)\} + \ldots + [1/(1+\sigma)^{T}]*\{\delta L[B(T),G(T)]/\delta G(T)\}*\{\delta G(T)/\delta B(T)\} =0$$

where:

$$(18) \quad \delta L[B(t),G(t)]/\delta B(t) = \alpha_B + \alpha_{BB}B(t) + \alpha_{BG}G(t) - \mu P_B(t)$$

and:

$$(19) \quad \delta L[B(t+i),G(t+i)]/\delta G(t+i) = \alpha_G + \alpha_{GG}G(t+i) + \alpha_{BG}B(t+i)$$

and:

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(20) $\delta(t+i)/\delta B(t) = (1 - \delta)^{i-1}$.

To simplify notation somewhat, make the following substitutions:

(21) $U_C(t) = \alpha_C + \alpha_{CC}\, C(t) + \alpha_{CA}\, A(t)$

and:

(22) $V_A(t) = \alpha_A + \alpha_{AA} A(t) + \alpha_{CA} C(t)$.

Making these substitutions and multiplying through by $(1+\sigma)^t$, the first order condition with respect to gambling consumption at time t, given above in equation (17), can be rewritten as:

(23) $U_B(t) = \mu\, P_B(t) - \Sigma_{i=1}^{\infty} V_G(t+i)[(1-\delta)^{i-1}/(1+\sigma)^i]$.

Similar equations can be derived for each t. To get an estimable demand equation, consider equation (23) for t-1:

(24) $U_B(t-1) = \mu\, P_B(t-1) - \Sigma_{i=1}^{\infty} V_G(t+i)[(1-\delta)^i/(1+\sigma)^{i+1}]$

$- V_G(t)/(1+\sigma)$

and at time t+1, adding and subtracting $(1-\sigma)^{-1} V_G(t+1)$:

(25) $U_B(t+1) = \mu\, P_B(t+1) - \Sigma_{i=1}^{\infty} V_G(t+i)[(1-\delta)^{i-2}/(1+\sigma)^{i-1}]$

$+ V_G(t+1)/(1-\delta)$.

Multiplying equation (23) by $(1-\delta)$, then dividing by $(1+\sigma)$ and subtracting (24) from the result yields:

(26) $[(1-\delta)/(1+\sigma)]U_B(t) - U_B(t-1) = \mu\{[(1-\delta)/(1+\sigma)]\, P_B(t)$

$- P_B(t-1)\} + V_G(t)/(1+\sigma)$.

Likewise, multiplying equation (25) by $(1-\delta)$, then dividing by $(1+\sigma)$ and subtracting equation (23) from the resulting equation yields:

(27) $[(1-\delta)/(1+\sigma)]U_B(t+1)-U_B(t) = \mu\{[(1-\delta)/(1+\sigma)]\, P_B(t+1)$

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$- P_B(t)\} + V_G(t+1)/(1+\sigma)$.

Multiplying (26) by $(1-\delta)$ and subtracting the resulting equation from (27), replacing U_B (i) and V_G (i) with (38) and (39), i = 1-1, t, t+1, and solving for B(t) yields:

$$(28)\ [(1-\delta)/(1+\sigma)][U_B(t+1)-(1-\sigma)U_B(t)]-[U_B(t)-(1-\sigma)U_B(t-1)]$$
$$= \mu\{(1-\delta)/(1+\sigma)P_C(t+1) - [1 + (1-\delta)^2/(1+\sigma)]P_C(t) +$$
$$(1-\sigma)P_C(t-1)\} + [1/(1+\sigma)]V_G(t+1)-[(1-\delta)/(1+\sigma)]V_G(t).$$

Recalling that the definitions of $U_B(t)$ and $V_G(t)$ given above and noting that:

$$(29)\ G(t+1) - (1-\sigma)G(t) = B(t)$$

the following equation is obtained:

$$(30)\ [(1-\delta)/(1+\sigma)]\{[\delta\alpha_B + \alpha_{BB}\,B(t+1) + [\alpha_{BG} - (1-\sigma)\alpha_{BB}]G(t)\}$$
$$- \{[\delta\alpha_B + \alpha_{BB}\,B(t) + [\alpha_{BG} - (1-\sigma)\alpha_{BB}]G(t-1)\} =$$
$$\mu\{(1-\delta)/(1+\sigma)P_C(t+1) - [1 + (1-\delta)^2/(1+\sigma)]P_C(t) +$$
$$(1-\sigma)P_C(t-1)\} + [1/(1+\sigma)]\{\delta\alpha_G + \alpha_{BG}B(t+1) +$$
$$[\alpha_{GG} - (1-\delta)\alpha_{BG}\}B(t).$$

Solving equation (30) for B(t) yields the following gambling demand equation:

$$(31)\ B(t) = \beta_0 + \beta_1\,P_B(t) + \beta_2 P_B(t-1) + \beta_3 P_B(t+1) +$$
$$\beta_4 B(t-1) + \beta_5 B\,(t+1)$$

where:

$$(32)\ \Omega = (2-\delta)/(1+\sigma)\alpha_{CA} - \alpha_{AA}/(1+\sigma)-\{1 + [(1-\delta)2/(1+\sigma)]\}\alpha_{CC}$$

$$(33)\ \beta_0 = \{\delta\alpha_G/(1+\sigma) - \delta a[(1-\delta)/(1+\sigma) - 1]\} / \Omega$$

$$(34)\ \beta_1 = \delta B(t)/\delta P_B\,(t) = - (\mu/\Omega)[1+(1-\delta)^2/(1+\sigma)]$$

$$(35)\ \beta_2 = \delta B(t)/\delta P_B\,(t-1) = (\mu/\Omega)(1-\delta)$$

$$(36)\ \beta_3 = \delta B(t)/\delta P_B\,(t+1) = (\mu/\Omega)[(1-\delta)/(1+\sigma)]$$

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(37) $\beta_4 = \delta B(t)/\delta B(t-1) = -(1/\Omega)[(1-\delta)\alpha_{BB} - \alpha_{BG}]$

and:

(38) $\beta_5 = \delta B(t)/\delta B(t+1) = [1/(\Omega(1+\sigma))][\alpha_{BG} - (1-\delta)\alpha_{BB}]$

Based on the assumptions of the model discussed above, the signs of each of the coefficients on the variables entering the gambling demand equation can be predicted. To begin with, the term Ω which enters each of the coefficients is positive since α_{BG} is assumed to be greater than zero (due primarily to the reinforcement effects involved in addictive consumption) and from concavity. β_1, the coefficient on the market price of cigarettes in time t, is expected to be negative, as one would expect. Past and future consumption of the addictive good are expected to have a positive effect on current consumption of the addictive good (that is, β_4 and β_5 are expected to be positive) with the effect of past consumption expected to be larger in magnitude than the effect of future consumption. More directly, the effect of future consumption on current consumption is expected to be equal to the discounted effect of past consumption on current consumption [$\beta_5 = \beta_4/(1+\sigma)$]. Similarly, the effect of past and future takeout rates on current consumption is predicted to be positive (β_2 and $\beta_3 > 0$) with the effect of the past price larger than the effect of the current price by the factor $(1+\sigma)$.

The prediction that a positive relationship exists between one lag and one lead of takeout rates and current

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betting consumption seems somewhat contradictory given that the main implication of the model of rational addictive behavior is that consumption of the addictive good, gambling, is complementary, not substitutable over time. In fact, Becker, Grossman and Murphy, in their application of the Becker-Murphy model of rational addiction to cigarette consumption using aggregate data, define a good as addictive "if and only if an increase in past consumption leads to an increase in the current consumption" holding prices, . . . and the marginal utility of wealth fixed [Becker, Grossman and Murphy (1990, page 7)]. Finding that β_4 is positive would be evidence that cigarettes are addictive, while finding that β_4 is negative or insignificantly positive (in an economic sense) would be evidence against the claim that cigarettes are addictive. A good is more addictive when the reinforcement from past consumption is greater. This definition means that a good is addictive if $\beta_4 > 0$, and if the degree of addiction is greater when β_4 is larger. However, past and future consumption are being held constant. Hence, the fact that and increase (decrease) in past price would result in a decrease (increase) in past consumption which would lead to a decrease (increase) in current consumption (if the consumption is addictive) is being controlled for by the inclusion of past consumption in the demand equation (and similarly for increases (decreases) in future prices).

Therefore, the implication that higher (lower) past

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and/or future prices lead to greater (less) current consumption holding past and future consumption constant implies that some other factor must be leading to greater current consumption. Becker, Grossman and Murphy suggest that this "other force" is the addictive stock. Evidence of the notion that past and future cigarette prices are picking up the effects of the unmeasured addictive stock is that the coefficients on past and future price (β_2 and β_3 in the demand equation (31), respectively) depend on the rate of depreciation on the addictive stock. That is, if the rate of depreciation on the addictive stock is assumed to be one hundred percent, the addictive stock at time t is then given by consumption at time t-1 (see equation (16)) and the coefficients on past and future prices go to zero, since the addictive stock is fully captured by past consumption.

More formally, if the rate of depreciation on the addictive stock is one hundred percent, the quadratic version of the utility function described in (1) at time t, becomes:

$$(39)\quad U(t) = aN(t) + aB(t) + aG(t-1) + (U_{NN}/2)[N(t)] + (U_{BB}/2)[B(t)]^2 + (U_{GG}/2)[B(t-1)]^2 + U_{NB}[N(t)B(t)] + U_{BG}[B(t)B(t-1)] + U_{NG}(N(t)B(t-1)].$$

Following the same logic as before, the typical first order condition with respect to gambling consumption at time t form the constrained utility maximization process in now given by:

$$(40)\quad \delta V^*[.]/\delta B(t) =$$

$$[\alpha_B + \alpha_{BB} + \alpha_{BG}B(t-1) - \mu P_B(t)]/[(1+\sigma)^t] +$$

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$$[\alpha_G + \alpha_{GG}B(t) + \alpha_{BG}B(t+1)]/[(1+\sigma)^{t+1}] = 0.$$

Solving this first order condition for B(t) yields the following gambling demand equation:

$$(41)\quad B(t) = \Gamma_0 + \Gamma_1 P_B(t) + \Gamma_2 B(t-1) + \Gamma_3 B(t+1).$$

where:

$$(42)\quad \epsilon = \alpha_{GG} /(1+\sigma) + \alpha_{BB}$$

$$(43)\quad \Gamma_0 = -(1/\epsilon) \{ [\alpha_G /(1+\sigma)] + \alpha_B \}$$

$$(44)\quad \Gamma_1 = \delta B(t) /\delta B(t-1) = \mu/\epsilon$$

$$(45)\quad \Gamma_2 = \delta B(t)/\delta B(t+1) = - \alpha_{BG} /\epsilon$$

and:

$$(46)\quad \Gamma_3 = \delta B(t)/\delta B(t+1) = - \alpha_{BG} /\epsilon(1+\sigma)$$

The predictions of this simpler model of addictive consumption concerning the effects of the current price of gambling, as well as the effects of past and future gambling consumption, on current gambling consumption are identical to those of the less restrictive model outlined above. Again, the past and future gambling prices fall out of the demand equation when the rate of depreciation on the addictive stock is one hundred percent, indicating that in the less restrictive model these prices are picking up those parts of the past and future addictive stocks which are not being captured by past and future consumption and which are exerting a positive influence on current consumption.

Finally, an alternative gambling demand equation developed within the Becker-Murphy rational addiction framework can be obtained directly from equation (27) which

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uses the first order conditions with respect to gambling consumption at time t and t+1. Making use of the definition of the addictive stock at time t+1, this equation can easily be solved for cigarette consumption at time t. The resulting gambling demand equation is:

(47) $B(t) = \Theta_0 + \Theta_1 P_B(t) + \Theta_2 P_B(t+1) + \Theta_3 B(t+1) + \Theta_4 G(t)$

where:

(48) $\Phi = [(1-\delta)/(1+\sigma)]\alpha_{BG} - \alpha_{BB} - [\alpha_{GG} /(1+\sigma)]$

(49) $\Theta_0 = (1/\Phi) \{[\alpha_G /(1+\sigma)] - \alpha_B [((1-\delta)/(1+\sigma))-1]\}$

(50) $\Theta_1 = \delta B(t)/\delta P_B(t) = \mu/\Phi$

(51) $\Theta_2 = \delta B(t)/\delta P_B(t+1) = - (\mu/\Phi)[(1-\delta)/(1+\sigma)]$

(52) $\Theta_3 = \delta B(t)/\delta B(t+1) =$

$(1/\Phi)[(\alpha_{BG} /(1-\delta))-(1-\delta)/(1+\sigma)\alpha_{BB}]$

and:

(53) $\Theta_4 = \delta B(t)/\delta G(t) = (1/\Phi)\{[1-((1-\delta)^2/(1+\sigma))\alpha_{BB}] +$

$\{[(1-\delta)/(1+\sigma)]\alpha_{GG}\}.$

As before, current gambling consumption is expected to be negatively related to the current price of gambling but positively related to next period's price. Similarly, increases in future consumption are predicted to lead to increased current consumption. However, the direction of the relationship between gambling consumption at time t and the level of the addictive stock at time t can not be predicted by the model. This ambiguity is due to two opposing forces represented by the stock. As discussed in chapter 5 an

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increase in the stock of past consumption leads to an increase in the shadow price of the addictive stock, and as a result, to an increase in the full price of gambling (due to the increase in all future stocks and, hence, reductions in all future utility levels). The increase in the full price of gambling should discourage consumption. If this were the only effect, then θ_4 would be expected to be negative. However, because of the reinforcement factors associated with the consumption of an addictive good (by $\alpha_{BG} > 0$), increased past consumption may lead to increased current consumption. If the positive effects of reinforcement in consumption outweigh the negative effects of the increase in the full price of gambling associated with an increase in the addictive stock, then θ_4 would be positive.

This demand equation reemphasizes the earlier discussion concerning the predicted positive relationship between current gambling consumption and the past and future prices of gambling when past and future gambling consumption and the marginal utility of wealth are being held constant. The basic argument was that the past and future prices were proxies for the unmeasured aspects of the addictive stock not controlled for by the presence of past and future gambling consumption. In this final model, both the past price of gambling and past gambling consumption are replaced by the stock of past gambling consumption, lending some support to earlier arguments.

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Myopic and Other Models of Gambling

Rationality, in the context of this dissertation implies not only that individuals realize that gambling could be an addictive behavior, but that they are aware of the future consequences of their actions and take this into account when making current consumption decisions. Myopia, on the other hand, suggests that individuals recognize that gambling could be an addictive behavior, but ignore the repercussions of their actions. In other words, they ignore not only the negative impact of gambling on wealth, but also the fact that all future consumption decisions will be dependent on current and all past consumption decisions. All future consumption decisions are affected due to the effects of consumption at any time on the addictive stock at all later times and the resulting impacts on productivity and, consequently, utility. In this context, therefore, myopia implies that individuals completely discount the future (or $\sigma \to \infty$).

Demand equations comparable to those derived under the assumption of rational behavior above can easily be derived under the alternative assumption of myopic behavior. Using the basic model defined above, begin from equation (15). Recalling the typical first order condition with respect to gambling consumption for this maximization problem given in equation (17), multiply through by $(1 + \sigma)^t$, and impose the assumption of myopia ($\sigma \to \infty$). The resulting equation is as follows:

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(54) $\alpha_B + \alpha_{BB}B(t) + \alpha_{BG}G(t) - \mu P_B(t) = 0$

Solving this equation for B_t yields a gambling demand equation comparable to equation (47) under the assumption of myopia as follows:

(55) $B(t) = \theta_0^M + \theta_1^M P_B(t) - \theta_4^M G(t)$

where:

(56) $\theta_0^M = - \alpha_B/\alpha_{BB}$

(57) $\theta_1^M = \delta B(t)/\delta P_B(t) = \mu/\alpha_{BB}$

and:

(58) $\theta 4^M = \delta B(t)/\delta G(t) = - \alpha_{BG}/\alpha_{BB}$

An inverse relationship is predicted between gambling consumption in time t and the relative price of bets in time t, as before. Under the assumption of myopic behavior, however, a definite prediction can be made concerning the relationship between the addictive stock at time t and gambling consumption at that time. Current consumption is expected to be positively related to the level of the addictive stock.

The prediction of a positve relationship between current gambling consumption and the depreciated sum of past consumption is consistent with expectations given the way in which the rationality versus myopia distinction is introduced. Recalling the earlier discussion about the ambiguity of the effect of the addictive stock on current gambling consumption in the fully rational specification derived above, it was noted that increases in the addictive stock increased the full

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price of gambling through an increase in the shadow price of the stock. The increase in the shadow price of the stock was due to the increase in all future stocks which decreased all future utility levels. If, however, people are behaving myopically and completely ignoring all of the future consequences of their addiction, then the shadow price of the stock will be zero and the full price of gambling will be equal to the market price of bets. Therefore, the only effect of the addictive stock is through its reinforcement of current gambling consumption, implying the positive relationship between the current consumption predicted by the myopic model.

Similarly, using equation (54), if the rate of depreciation on the addictive stock is assumed to be one hundred percent, then the following gambling demand equation is obtained:

(59) $B(t) = \Gamma_0^M + \Gamma_1^M P_B(t) - \Gamma_2^M B(t-1)$

where:

(60) $\Gamma_0^M = - \alpha_B/\alpha_{BB}$

(61) $\Gamma_1^M = \delta B(t)/\delta P_B(t) = \mu/\alpha_{BB}$

and:

(62) $\Gamma_2^M = \delta B(t)/\delta B(t-1) = - \alpha_{BG}/\alpha_{BB}$

Again, the predicted relationships between current gambling consumption and the current bet price and lagged gambling consumption are qualitatively identical to those of the demand equation under the assumption of fully rational behavior given as equation (41).

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To obtain the myopic equivalent of the demand equation given by equation (31) above, consider equation (54) for time (t - 1):

(63) $\alpha_B + \alpha_{BB}B(t-1) + \alpha_{BG}G(t-1) - \mu P_B(t-1) = 0$

Multiplying this equation by $(1 - \delta)$ and subtracting the resulting equation from equation (54) yields the following:

(64) $B(t) - (1-\delta)B(t-1) = -\delta\alpha_B/\alpha_{BB} + \mu/(\alpha_{BB}P_B(t)) - \mu(1-\delta)/(\alpha_{BB}P_B(t-1)) - \alpha_{BG}/(\alpha_{BB}G(t)) + \alpha_{BG}/(\alpha_{BB}G(t-1))$

Recalling equation (29), solving (64) for B_t yields the following gambling demand equation:

(65) $B(t) = \beta_0^M + \beta_1^M P_B(t) + \beta_2^M P_B(t-1) + \beta_4^M B(t-1)$

where:

(66) $\beta_0^M = -\delta\alpha_B/\alpha_{BB}$

(67) $\beta_1^M = \delta B(t)/\delta P_B(t) = \mu/\alpha_{BB}$

(68) $\beta_2^M = \delta B(t)/\delta P_B(t-1) = -\mu(1-\delta)/\alpha_{BB}$

and:

(69) $\beta_4^M = \delta B(t)/\delta B(t-1) - \alpha_{BG}/\alpha_{BB}$

As in the gambling demand equation derived under the assumption of rational behavior, current gambling consumption is expected to be inversely related to the current price of bets, but directly related to the lagged price of bets and lagged gambling consumption.

Finally, if gambling is modeled as a non-addictive behavior, then consumption is expected to be intertemporally independent. The gambling demand equation resulting from this behavioral assumption will then be solely a function of

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relative prices and income. All past and future consumption effects will be excluded.

Empirically Testable Implications of the Model of Rational Addiction

Comparing the demand equations derived under the alternative assumptions of non-addictive, addictive but myopic, and addictive and rational behavior leads to several empirically verifiable hypotheses. The two main tests of the model are to test whether or not gambling is an addictive behavior and, if addictive, are individuals behaving rationally or myopically.

As noted earlier, the Becker-Grossman-Murphy test of addiction is relatively straightforward. The main implication of addiction in their model is that consumption of the addictive good displays "adjacent complementarity." In this work, that implies that gambling consumption in consecutive periods is positively related, or that increases (decreases) in past consumption leads to increases (decreases) in current consumption. Therefore, to test for the presence of addiction, one has simply to look at the estimates obtained for the coefficients on past consumption when estimating the demand equations. If these coefficients (β_4 in equation (31) and (Γ_2 in equation (41)) are positive and significant, then the addictive model discussed above is an accurate description of gambling.

As Becker, Grossman, and Murphy note, and interesting

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test of the appropriateness of the model of addiction outlined in Chapter Five would be to estimate demand equations similar to those earlier in this chapter for goods which are a priori non-addictive. If the model is accurately describing addiction and not just the effects of persistence or habits on demand, then the effects of past consumption on current consumption should be either negligible or negative.

Comparing the two sets of demand equations derived under alternative assumptions yields a relatively simple test for rational behavior versus myopic behavior. The predictions of the myopic models and the rational models of gambling are identical with respect to the direction of the relationships between current gambling consumption and the current price of bets, the lagged price of bets, and lagged gambling consumption.

The key difference between the models involve future effects. The rational model predicts that current gambling consumption will be positively affected by the future price of bets and future gambling consumption, with the magnitude of these effects less than their respective past effects by the factor $(1 + \sigma)$. The myopic models, however, predict that future price and consumption will have no impact on current consumption decisions. Examples of a myopic model of the demand for gambling are presented by Chaloupka (1988), (1989) and Becker, Grossman, and Murphy (1990), in which a demand equation comparable to (47) is derived within a utility

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maximization framework, and subsequently estimated.

Therefore, if positive and significant coefficients of the appropriate magnitude are estimated for the future price and consumption of gambling, the rationality hypothesis would be validated. If, on the other hand, these estimated coefficients are not significantly different from zero or are negative, then the hypothesis of rational behavior would be rejected in favor of the alternative hypothesis of myopic behavior. Finally, with respect to demand equation (47), finding no significant positive relationships between current gambling consumption and future gambling consumption, but obtaining positive and significant estimates of the coefficient on the addictive stock would lend additional support to the argument that individuals are behaving myopically.

The most important test of rationality versus myopia appears to be the estimated coefficient on future consumption (β_5 in demand equation (31), Γ_3 in demand equation (41), and θ_3 in demand equation (47)). Relatively high rates of depreciation on the addictive stock would imply a fairly weak relationship between the future (and past) betting price and current gambling consumption, while the coefficients on future consumption are less affected.

Finally, Becker and Murphy, and Becker, Grossman, and Murphy derive several testable implications of the short and long-run responses to changes in price. Additionally, Becker,

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Grossman, and Murphy distinguish between the effects of unanticipated changes in prices as well as the relative effects of temporary versus permanent price changes. The discussion which follows draws heavily on this work.

As noted by Becker, Grossman, and Murphy (page 9), the gambling demand equations derived above as equations (31) and (41) are second-order difference equations in current gambling consumption, B(t). The dynamics of consumption, therefore, can be described by the two roots of the quadratic equation (based on equation (31)):

(70) $0 = -\phi^2 \beta_4 + \phi - \beta_5$

where the two roots of this equation are:

(71) $\phi_1 = [1 - \surd(1 - 4\beta_4\beta_5)]/2\beta_4$

and:

(72) $\phi_2 = [1 + \surd(1 - 4\beta_4\beta_5)]/2\beta_4$

Becker, Grossman, and Murphy note that both ϕ_1 and ϕ_2 are real (from the assumption of concavity which implies that $4\beta_4\beta_5 < 1$) and therefore, will both be the same sign as β_4. This implies that both roots are positive if consumption is addictive (indicated by $\beta_4 > 0$, as discussed above). Similar equations are obtained for demand equation (41), replacing β_4 and β_5 with Γ_2 and Γ_3, respectively, where Γ_2 being positive and significant indicates addiction. Finally, comparable equations can be derived for (47), replacing β_4 with θ_4/δ and β_5 with θ_3. These equations are based on the assumption that a constant optimal level of the addictive stock is maintained

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in the steady state and that consumption at any time just offsets depreciation on the addictive stock.

Becker, Grossman, and Murphy develop several different price elasticities of demand based on the basic demand equations derived above (with a detailed development of the elasticities corresponding to their version of the gambling demand equation as equation (41) above). These price elasticities of demand are based upon the general solutions to the second-order difference equations represented by each of the gambling demand equations above, and each will be developed below for each of these demand functions.

The general solution to the second-order difference equation in which the rate of depreciation on the addictive stock is assumed to be one hundred percent (equation (41)) is, using the appropriate roots:

$$(73)\quad B(t) = [1/(\Gamma_2\phi_1(\phi_2 - \phi_1))]*[\Sigma^{\infty}_{s=1}\ \phi_1^{s}\ h(t+s)] + [1/(\Gamma_2\phi_1(\phi_2 - \phi_1))]*[\Sigma^{\infty}_{s=0}\ \phi_2^{-s}\ h(t-s)] + (1/\phi_2^{t})*\{B^0 - [1/(\Gamma_2\phi_1(\phi_2 - \phi_1))]*[\Sigma^{\infty}_{s=1}\ \phi_1^{s}\ h(s)]\}$$

where:

$$(74)\quad h(t) = \Gamma_0 + \Gamma_1 P_B(t-1)$$

and B^0 is assumed constant.

Using this equation, the effects of changes in past, current, and future consumption can easily be determined. Using the Becker-Grossman-Murphy nomenclature, the effect of changes in current price demand are as derived by Chaloupka (1986):

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(75) $\delta B(t)/\delta P_B(t) = [\Gamma_1/\Gamma_2(\phi_2 - \phi_1)]*[1 - (\phi_1/\phi_2)^t]$

The effect of a change of past price on current consumption is given as (where $\tau < t$):

(76) $\delta B(t)/\delta P_B(\tau) = [\Gamma_1\phi_2^{\tau-t}/\Gamma_2(\phi_2 - \phi_1)]*[1 - (\phi_1/\phi_2)^\tau]$

The effect of a change in future price on demand is (where $\tau > t$):

(77) $\delta B(t)/\delta P_B(\tau) = [\Gamma_1\phi_1^{\tau-t}/\Gamma_2(\phi_2 - \phi_1)]*[1 - (\phi_1/\phi_2)^\tau]$

Each of these will be negative if consumption is addictive ($\Gamma_2 < 0$). These price effects are defined for temporary changes in the price of bets and are what Becker, Grossman, and Murphy refer to as "anticipated" price effects. Letting the term in brackets become $(\phi_2 - \phi_1)/\phi_2$, the Becker-Grossman-Murphy "unanticipated" price effects are obtained.

More interesting are the effects on gambling demand of permanent changes in the price of gambling. Becker, Grossman, and Murphy define the effects of two different permanent price changes. The first is what they call the "short-run" price effect. This is the effect on current consumption of a permanent change in price beginning in the current period, and is obtained by summing all future price effects and the current price effect defined above. The resulting price effect (their "all future prices anticipated") is:

(78) $\delta B_{\bullet}/\delta P_{\bullet} = \Gamma_1/[\Gamma_2(1 - \phi_1)(\phi_2 - \phi_1)]$

with the comparable unanticipated price effect as:

(79) $\delta B_{\bullet}/\delta P_{\bullet} = \Gamma_1/[\Gamma_2(1 - \phi_1)(\phi_2 - \phi_1)]*[(\phi_2 - \phi_1)/\phi_2]$

Finally, the effect on current consumption of a change in

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prices in all periods is given as:

$$(80)\quad \delta B_{\cdot}/\delta P = \Gamma_1/[\Gamma_2(1 - \phi_1)(\phi_2 - 1)]$$

This is the long-run or steady state price effect. This is the long-run response to a permanent price reduction. Based on equations (78) and (80), several points can be made. If consumption is addictive, an increase in past, current, or future price should lead to a reduction in current consumption, with the response to changes in future prices a potential test for rationality. Also, if consumption is addictive, the long-run price effect should be larger in magnitude that the short-run price effect (in this case by the term $(\phi_2 - \phi_1)/(\phi_2 - 1)$). Additionally, if consumption is addictive, the anticipated price effects should be larger in magnitude than the comparable unanticipated price effects (by the factor $\phi_2/(\phi_2 - \phi_1)$ for this demand equation). Finally, it should be clear that if the addictive aspects of consumption are ignored then the estimated price effects would be significantly different from those defined above.

It remains to develop the comparable price effects for the other two demand equations developed above. The same basic conclusions outlined above with the respect to the magnitudes of the expected price effects of modelling consumption as a rational addictive behavior will apply to the price effects developed here as well.

The general solution to the second-order difference equation derived as demand equation (31) above is, with ϕ_1 and

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ϕ_2 as defined above:

$$(81)\ B(t) = [1/(\beta_4\phi_1(\phi_2 - \phi_1))]*[\Sigma^{\infty}_{s=1}\ \phi_1^{s}\ g(t+s)] + [1/(\beta_4\phi_2(\phi_2 - \phi_1))]*[\Sigma^{\infty}_{s=0}\ \phi_2^{-s}\ g(t-s)] + (1/\phi_2^{t})\{G^0 - [1/(\beta_4\phi_1(\phi_2 - \phi_1))]*[\Sigma^{\infty}_{s=1}\ \phi_1^{s}\ g(t)]\}$$

where:

$$(82)\ g(t) = \beta_0 + \beta_1 P_B(t-1) + \beta_2 P_B(t-2) + \beta_3 P_B(t)$$

and G^0 is assumed constant.

The effects on consumption of temporary, anticipated changes in current, past, and future prices are as follows:

$$(83)\ \delta B(t)/\delta P_B(t) = [\beta_1 + \beta_2\phi_1 + \beta_3\phi_2^{-1}]/[\beta_4(\phi_2 - \phi_1)]$$

$$(84)\ \delta B(t)/\delta P_B(t-1) = [1/(\beta_4(\phi_2 - \phi_1))] * [\beta_2 + \beta_1/\phi_2 + \beta_3/\phi_2^{2}]$$

and:

$$(85)\ \delta B(t)/\delta P_B(t+1) = [\beta_3 + \phi_1\beta_1 + \phi_1^{2}\beta_2]/\beta_4(\phi_2 - \phi_1)]$$

with the comparable unanticipated effects of temporary changes in current, past, and future price defined as:

$$(86)\ \delta B(t)/\delta P_B(t) = [\beta_1 + \beta_2\phi_1]/\beta_4\phi_2$$

$$(87)\ \delta B(t)/\delta P_B(t-1) = [\beta_1/\beta_4\phi_2^{2}] + [\beta_2/\beta_4(\phi_2 - \phi_1)] * [1-(\phi_1^{2}/\phi_2^{2})]$$

and:

$$(88)\ \delta B(t)/\delta P_B(t+1) = [\beta_3 + \phi_1\beta_1 + \phi_1^{2}\beta_2]/\beta_4\phi_2]$$

The effect on current consumption of an anticipated permanent change in price beginning in the current period, the short-run price effect, is defined as:

$$(89)\ \delta B_{*}/\delta P_{*} = \{\beta_1 + \phi_1\beta_2 + \beta_3[1 + (1 - \phi_1)/\phi_2]\} / [\beta_4(1 - \phi_1)(\phi_2 - \phi_1)]$$

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with the unanticipated effect given as:

$$(90)\ \delta B_{*}/\delta P_{*} = [\beta_1 + \phi_1\beta_2 + \beta_3]/[\beta_4(1 - \phi_1)\phi_2]$$

Finally, the effect on current consumption of a change in prices in all periods, the long-run or steady state price effect, is given as:

$$(91)\ \delta B_{*}/\delta P = [\beta_1 + \beta_2 + \beta_3]/[\beta_4(1 - \phi_1)(\phi_2 - 1)]$$

Finally, for the second-order difference equation described by demand equation (47) above (under the assumption that steady state consumption is just sufficient to offset the depreciation on the optimal level of the addictive stock), the general solution is:

$$(92)\ B(t) = [1/(\theta\phi_1(\phi_2 - \phi_1))]*[\Sigma^{\infty}_{s=1}\ \phi_1^{s}\ f(t+s)] + [1/(\theta\phi_2(\phi_2 - \phi_1))]*[\Sigma^{\infty}_{s=0}\ \phi_2^{-s}\ f(t-s)] + (1/\phi_2^{t})\{G^{0} - [1/(\theta\phi_1(\phi_2 - \phi_1))]*[\Sigma^{\infty}_{s=1}\ \phi_1^{s}\ f(s)]\}$$

where:

$$(93)\ f(t) = \theta + \theta_1 P_B(t-1) + \theta_2 P_B(t)$$

G^0 is assumed constant, θ is defined as θ_4/δ, and the two roots are as described above.

The effects on consumption of temporary, anticipated changes in current, past, and future prices are as follows:

$$(94)\ \delta B(t)/\delta P_B(t) = [\theta_1 + \theta_2\phi_2^{-1}]/\theta(\phi_2 - \phi_1)$$

$$(95)\ \delta B(t)/\delta P_B(t-1) = [\theta_1 + \theta_2\phi_2^{-1}]/\theta(\phi_2 - \phi_1)\phi_2$$

and:

$$(96)\ \delta B(t)/\delta P_B(t+1) = [\theta_2 + \theta_1\phi_1]/\theta(\phi_2 - \phi_1)$$

with the comparable unanticipated effects of temporary changes in current, past, and future price defined as:

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$$(97)\quad \delta B(t)/\delta P_B(t) = \theta_1 / \theta\phi_2$$

$$(98)\quad \delta B(t)/\delta P_B(t-1) = \theta_1 / \theta\phi_2^{\,2}$$

and:

$$(99)\quad \delta B(t)/\delta P_B(t+1) = [\theta_2 + \phi_1\theta_1]/\theta\phi_2$$

The effect of a permanent price change beginning in the current period which was anticipated, the anticipated short-run effect, is:

$$(100)\quad \delta B_*/\delta P_* = \{\theta_1 + \theta_2[1 + (1 - \phi_1)/\phi_2]\} / [\theta(1 - \phi_1)(\phi_2 - \phi_1)]$$

with the unanticipated effect given as:

$$(101)\quad \delta B_*/\delta P_* = [\theta_1 + \theta_2]/[\theta(1 - \phi_1)\phi_2]$$

Finally, the effect of a permanent price change in all periods on current consumption, the long-run or steady state effect, is:

$$(102)\quad \delta B_*/\delta P = [\theta_1 + \theta_2]/[\theta(1 - \phi_1)(\phi_2 - 1)]$$

Again, as noted by Becker, Grossman, and Murphy, the various price elasticities of demand derived within the rational addiction framework, implying that ignoring the addictive aspects of consumption will lead to incorrect estimates of the responses by addicts to changes in past, current, and/or future price changes. Also, within the addictive framework, the effects of anticipated changes in price differ from the effects of unanticipated price changes. Finally, models of the demand for addictive goods which fail to account for the addictive aspects of consumption predict no differences in the short-run versus long-run price elasticities of demand, as

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they are defined above, while the Becker-Murphy model of rational addiction predicts that the long-run response to a permanent change in price will be greater than the short-run response.

One final point to be made briefly in this chapter concerns the appropriate estimation strategy. Each of the gambling demand equations derived above contains both next period's consumption of the addictive good and some measure of past consumption, in addition to current gambling prices and alternative sets of the price of gambling last period and the price of gambling next period. However, both future consumption and the measures of past consumption employed are themselves dependent on current consumption. As noted by Becker, Grossman, and Murphy, the general solution to the second-order difference equations presented by these demand equations suggest a solution to the endogeneity problem. These solutions show that consumption at any time is a function of all past, current, and future gambling prices. However, the demand equations derived include at most one lead and one lag of the price of bets, in addition to the current price of bets. This suggests that estimating the demand equations derived above using instrumental variables for future and past consumption, where the instruments are further leads and lags of betting prices, will alleviate the endogeneity problem.

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Chapter Seven

Data, Market and Variable Construction

Data

This chapter contains a description of the data, market area and variables employed in the estimation of the demand equations derived in chapter Six. Also contained is a discussion of the construction of the various consumption measures used in the estimation. Finally, a discussion of the price variables utilized and the methodological problems associated with developing an appropriate measure of price are presented.

Gambling at United States horse tracks only will be studied in this dissertation, however other data has been collected for consideration. Data are aggregate, by state for lotteries, and by track market area for race tracks. The data are from official reports of gambling issued by states (lotteries) or to state agencies (thoroughbred horse and greyhound dog racing). There is no reporting or conjecture about illegal gambling on such events. It is unlikely that there is illegal gambling on state lotteries, however there are illegal numbers games available to many residents. There is illegal gambling provided by bookmakers on horse or greyhound racing events. This study makes no allowances for, or conjectures about illegal gambling.

The time period considered for horse tracks is 1950-1987, for dog tracks is 1950-1986, and for lotteries is 1963-1987.

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Only results for horseracing are presented. The matrix formed by the pooled cross section is unbalanced since not all tracks were in operation in 1950, nor did all tracks stay in business until 1987. The same is true for lotteries. The first lottery came into being in 1963 with other states entering at various times until 1987.

There may be pitfalls in using county and times series data. Consumption of gambling may have been substantially affected by the increased availability of gambling. In 1950, there were 61 horses tracks, 22 greyhound dog tracks, and 0 state lotteries compared to 87 horse tracks in 1987, 50 greyhound dog tracks in 1986, and 29 authorized state lotteries in 1987.

Pari-Mutuel data

Data were collected on pari-mutuel horseracing from American Racing Manual (1951-1988 editions). Data were not complete and there were errors in printing as well as several missing data points. Whenever possible missing data or corrections to the data were supplied by Thoroughbred Racing Communications, the Daily Racing Form (1976-1987), New York State Racing and Wagering Board, the National Association of State Racing Commissioners, or Christiansen (1984a,b,c,d).

Data were collected on pari-mutuel greyhound racing from American Greyhound Track Operators Summary of Pari-Mutuel Tax Structures. Tables 7-1 and 7-2 list the names and locations of horseracing tracks and greyhound tracks respectively.

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Table 7-1

Name and Location of Horseracing Tracks

Track	Location
AK-SAR-BEN	OMAHA, NB
ALBUQUERQUE	ALBUQUERQUE, NM
AQUEDUCT	OZONE PARK, NY
ARAPAHOE PARK	AURORA, CO
ARIZONA DOWNS	PHOENIX, AZ
ARLINGTON PARK	ARLINGTON PARK, IL
ASCOT PARK	NORTH CANTON, OH
ATLANTIC CITY	ATLANTIC CITY, NJ
ATOKAD PARK	SIOUX CITY, SD
AUDUBON PARK	HENDERSON, IL
BALMORAL	CRETE, IL
BAY MEADOWS	SAN MATEO, CA
BAY MEADOWS FAIR	SAN MATEO, CA
BEL AIR	BEL AIR, MD
BELMONT PARK	ELMONT, NY
BERKSHIRE DOWNS	HANCOCK, MA
BEULAH/DARBY DOWNS	GROVE CITY, OH
BILLINGS	BILLINGS, MT
BLUE RIBBON DOWNS	SALLISAW, OK
BOISE	BOISE, ID
BOWIE	BOWIE, MD
BROCKTON FAIR	BROCKTON, MA
CAHOKIA DOWNS	EAST ST. LOUIS, IL
CALDER	MIAMI, FL
CANTERBURY DOWNS	SHAKOPEE, MN
CENTENNIAL	DENVER, CO
CHARLES TOWN	CHARLES TOWN, WV
CHURCHILL DOWNS	LOUISVILLE, KY
COEUR D'ALENE	COEUR D'ALENE, ID
COLUMBUS	COLUMBUS, NB
COMMONWEALTH/MILES PARK	LOUISVILLE, KY
CRANWOOD	WARRENSVILLE HEIGHTS, OH
CUMBERLAND	CUMBERLAND, OH
DEL MAR	SAN DIEGO, CA
DEL MAR FAIR	SAN DIEGO, CA
DELAWARE PARK	STANTON, DE
DELTA DOWNS	VINTON, LA
DETROIT	LIVONIA, MI
DOVER DOWNS	DOVER, DE
EAST MOLINE DOWNS	EAST MOLINE, IL
ELLIS PARK	HENDERSON, KY
ERIE DOWNS/COMMODORE	ERIE, PA
EVANGELINE DOWNS	LAFAYETTE, LA
FAIR GROUNDS	NEW ORLEANS, LA
FAIR HILL	FAIR HILL, MD
FAIRGROUNDS PHOENIX	PHOENIX, AZ

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Table 7-1 continued

Name and Location of Horseracing Tracks

Track	Location
FAIRMOUNT PARK	COLLINSVILLE, IL
FAIRVIEW	FAIRVIEW, OR
FERNDALE	FERNDALE, CA
FINGER LAKES	FARMINGTON, NY
FLORIDA/SUNSHINE PARK	OLDSMAR, FL
FONNER PARK	GRAND ISLAND, NB
FRESNO	FRESNO, CA
GARDEN STATE	CHERRY HILL, NJ
GOLDEN GATE	ALBANY, CA
GRANTS PASS	GRANTS PASS, OR
GREAT BARRINGTON FAIR	GREAT BARRINGTON, MA
GREAT FALLS	GREAT FALLS, MA
GREEN MOUNTAIN	POWNAL, VT
GRESHAM PARK	GRESHAM, OR
GULFSTREAM PARK	HALLANDALE, FL
HAGERSTOWN	HAGERSTOWN, MD
HAMILTON	HAMILTON, OH
HARBOR PARK/ELMA	ELMA, WA
HAWTHORNE	CICERO, IL
HAZEL PARK	HAZEL PARK, IL
HIALEAH	HIALEAH, FL
HOLLYWOOD PARK	INGLEWOOD, CA
JAMAICA	JAMAICA, NY
JEFFERSON DOWNS	KENNER, LA
KEENELAND	LEXINGTON, KY
LA MESA	RATON, NM
LAKES REGION	BELMONT, NH
LAS VEGAS	LAS VEGAS, NV
LAUREL RACE COURSE	LAUREL, MD
LIBERTY BELL PARK	PHILADELPHIA, PA
LINCOLN DOWNS	PAWTUCKET, MA
LINCOLN STATE FAIR	LINCOLN, NB
LONG ACRES	RENTON, WA
LOS ALAMITOS	COSTA MESA, CA
LOUISIANA DOWNS	BOSSIER CITY, LA
MADISON DOWNS	MADISON, NB
MARLBORO	UPPER MARLBORO, MD
MARSHFIELD FAIR	MARSHFIELD, MA
MAUMEE DOWNS/FORT MIAMI	MAUMEE, OH
MEADOWLANDS	EAST RUTHERFORD, NJ
MEMORIAL PARK	BRUSH, CO
METRO PARK	METRO PARK, NJ
MITCHELL	MITCHELL, NB
MONMOUTH PARK	OCEANPORT, NJ
MOUNTAINEER/WATERFORD	CHESTER, WV
NARRAGANSETT PARK	PAWTUCKET, RI

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Table 7-1 continued

Name and Location of Horseracing Tracks

Track	Location
NORTHAMPTON	NORTHAMPTON, MA
OAKLAWN PARK	HOT SPRINGS, AR
OMAHA	OMAHA, NB
PARK JEFFERSON	JEFFERSON, SD
PENN NATIONAL	GRANTVILLE, PA
PHILADELPHIA PARK/KEYSTONE	BENSALEM, PA
PIKES PEAK	FOUNTAIN, CO
PIMLICO	BALTIMORE, MD
PITT PARK	MEADOWLANDS, PA
PLAYFAIR	SPOKANE, WA
PLEASANTON	PLEASANTON, CA
POCONO DOWNS	WILKES BARRE, PA
POMONA	POMONA, CA
PORTLAND MEADOWS	PORTLAND, OR
PRESCOTT DOWNS	PRESCOTT, AZ
PURCHASE	PURCHASE, NY
RACEWAY PARK	TOLEDO, OH
RANDALL PARK	NORTH RANDALL, OH
RAPID CITY	RAPID CITY, SD
RILLETO/TUCSON	TUCSON, NM
RIVER DOWNS	CINCINNATI, OH
ROCKINGHAM PARK	SALEM, NH
RUIDOSO	RUIDOSO, NM
SACRAMENTO	SACRAMENTO, CA
SALEM	SALEM, OR
SAN JUAN DOWNS	FARMINGTON, NM
SAN MATEO FAIR	SAN MATEO, CA
SANDHILLO PARK	ALLIANCE, NB
SANTA ANITA PARK	ARCADIA, CA
SANTA FE	SANTA FE, NM
SANTA ROSA	SANTA ROSA, CA
SARATOGA	SARATOGA SPRINGS, NY
SARBOROUGH DOWNS	SCARBOROUGH, ME
SEMINOLE TURF CLUB	CASSELBURY, FL
SHENANDOAH DOWNS	CHARLES TOWN, WV
SOLANO	VALLEJO, CA
SPORTSMANS PARK	CICERO, IL
STOCKTON	STOCKTON, CA
SUFFOLK DOWNS	EAST BOSTON, MA
SUN DOWNS	KENNEWICK, WA
SUNLAND PARK	SUNLAND PARK, NM
TAMPA BAY DOWNS	OLDSMAR, FL
TANFORAN	SAN BRUNO, CA
THISTLEDOWN	NORTH RANDALL, OH
THUNDERBIRD DOWNS	LAS VEGAS, NV
TIMONIUM	TIMONIUM, MD

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Table 7-1 continued

Name and Location of Horseracing Tracks

Track	Location
TROPICAL PARK	CORAL GABLES, FL
TURF PARADISE	PHOENIX, AZ
TURFWAY PARK/LATONIA	FLORENCE, KY
UNITED HUNTS	ELMONT, NY
URANIUM DOWNS	GRAND JUNCTION, CO
WASHINGTON PARK	HOMEWOOD, IL
WEYMOUTH FAIR	SOUTH WEYMOUTH, MA
WHEELING DOWNS	WHEELING, WV
WYOMING DOWNS	EVANSTON, WY
YAKIMA MEADOWS	YAKIMA, WA

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Table 7-2

Name and Location of Greyhound Tracks

Track	Location
AMADO	AMADO, AZ
APACHE	PHOENIX, AZ
ASSOCIATED	TAMPA, FL
AZALEA	MOBILE
BAYARD	JACKSONVILLE, FL
BISCAYNE	MIAMI, FL
BLACK CANYON	PHOENIX, AZ
BLACK HILLS	RAPID CITY, SD
BLUFFS RUN	COUNCIL BLUFFS, IA
BONITA	BONITA SPRINGS, FL
BYERS	DENVER, CO
CLOVERLEAF	FT. COLLINS, CO
COCHISE PARK	BENSON, AZ
DADE PARK	HENDERSON, KY
DAYTONA	DAYTONA BEACH, FL
DUBUQUE	DUBUQUE, IA
ESSEX	SALEM, MA
GREYHOUND PHOENIX	PHOENIX, AZ
GREYHOUND TUCSON	TUCSON, AZ
GREEN MOUNTAIN	POWNAL, VT
GREENETRACK	EUTAW, AL
HINSDALE	HINSDALE, NH
INVESTMENT	HOLLYWOOD, FL
JACKSONVILLE	JACKSONVILLE, FL
JEFFERSON	MONTICELLO, FL
KEY WEST	MIAMI, FL
LAS VEGAS DOWNS	LAS VEGAS, NM
LINCOLN	PAWTUCKET, RI
MASSASOIT	RAYNHAM,MA
MIAMI	MIAMI, FL
MIDDLEBORO	RAYNHAM, MA
MILE HIGH	DENVER, CO
MOBILE	MOBILE, AL
MULTNOMAH	FAIRVIEW, OR
MULTNOMAH FAIR	FAIRVIEW, OR
ORANGE	ORLANDO, FL
OREGON RAC. COMM	FAIRVIEW, OR
PALM BEACH	WEST PALM BEACH, FL
PENSACOLA	PENSACOLA, FL
PLAINFIELD	PLAINFIELD, CT
PUEBLO	PUEBLO, CO
REHOBOTH	TAUNTON, MA
REVERE	REVERE, MA
ROCKY MOUNTAIN	COLORADO SPRINGS, CO
SANFORD	LONGWOOD, FL
SARASOTA	SARASOTA, FL

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Table 7-2 continued

Name and Location of Greyhound Tracks

Track	Location
SEABROOK	SEABROOK, NH
SEMINOLE	SEMINOLE, FL
SOUTHERN DAKOTA	NORTH SIOUX CITY, SD
SOUTHLAND	WEST MEMPHIS, AR
ST. PETERSBURG	TAMPA, FL
TAUNTON	DIGHTON, MA
TRISTATE	CROSS LANE, WV
VICTORYLAND	SHORTER, AL
WASHINGTON	EBRO, FL
WATERLOO	WATERLOO, IA
WEST FLAGLER	MIAMI, FL
WESTERN	PHOENIX, AZ
WHEELING DOWNS	WHEELING, WV
YUMA	YUMA, AZ

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Lottery Data

Lottery data was collected for consideration in the models. Lottery revenues by type of game were obtained from annual reports from the various state lotteries supplemented by The Lottery Book published by Gaming and Wagering Magazine (1986). The data include handles by state for instant lotteries, pick three, pick four, and lotto games. Table 2-8 lists state lotteries.

Market

The track will be the unit of observation, so data specific to that area will be needed. The determination of the MSA the contiguous MSA's, as well as RSA's will allow a determination of a geographic area that will yield a geographic market area for a particular horse or greyhound track. The determination of the market is crucial for the analysis. The procedure to determine the market area is described below.

The track is located on a map using information collected from data sources. The name of the Metropolitan Statistical Area (MSA) is determined using the Rand McNally Sales and Marketing Atlas (1986). Then, the name of any MSA that is contiguous to the MSA where the track is located is recorded. Counties in all relevant MSA's were then determined using the U.S. Bureau of Census City and County Data Book. The Rural Statistical Areas (RSA) that surround that MSA where the tracked is located are recorded. The counties in each

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contiguous RSA are recorded. RSA information was supplied by Cellular Information Service based on Federal Communications Commission (FCC) designations.

RSA's were developed by the FCC in order to assign licenses for cellular telephone markets. The RSA delineations were based on common access within the RSA county group determined mostly by transportation routes. This will be an excellent delineation for tracks because one of the major determinants of the horse track market will be the ease of access to the track. The RSA's were delineated in 1983 and the same grouping will be used throughout the time period of the analysis. MSA's have also changed over time. The MSA's definition from 1983 will be used.

The use of state data was rejected because of higher level of aggregation and because of the geographic dispersity of state populations. An example of this can be demonstrated with Aqueduct horsetrack. Aqueduct is located in New York City inside New York State. Using state data, cities such as Buffalo (also in New York State) would be included in the market. However, Buffalo is approximately 500 miles away from Aqueduct. There is a very small probability that someone living in Buffalo will attend Aqueduct. It is more likely that someone living in Stamford, CT (where there are no horsetracks) would attend Aqueduct, based solely on distance.

The market determination procedure can be summarized as follows:

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1. Locate track using information supplied by TRC.

2. Note MSA name on Rand McNally Sales and Marketing Atlas.

3. Note any contiguous MSA's (that is an MSA touching, or sharing a common boundary, with the MSA in which the track is located).

4. Look at RSA map to determine the RSAs that surround the MSA. Only RSAs sharing a common border with the MSA in which the track was located are considered surrounding.

5 If the track is located outside an MSA note the RSA number in which the track is located. Then note any MSA or other RSA that shares a common boundary with the RSA where the track is located.

6. Note the county names in the MSA's and RSA's. (MSA's derived from Department of Commerce, Bureau of Census RSA's derived from Federal Communications Commission).

<u>Takeout Rates</u>

Based on the MSA location of the track and the determined geographic market, takeout rates were added to the data set. Takeout rates were obtained from National Council of State Racing Commissioners', annual compilation of gambling data for horseracing tracks and the Summary of State Pari-Mutuel Tax Structures for greyhound tracks. The takeout is legislated at the state level and pertains to any track operating within the state with few exceptions. Four lags and four leads of

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takeout rates are added to the data set.

At this point, one important methodological issue arises. As discussed above, there are substantial differences in takeout rates across states. This creates an incentive for gamblers to consume gambling in a low takeout locality rather than in their own residence locality with higher prices. The incentive for doing this will depend on several factors, including the price difference and the cost of transportation from one area to another. This implies that the magnitude of this problem increases the closer an individual lives to a lower price locality. This case will also exist for those who live in a locality where gambling is not legal and therefore not available. In this case gamblers will consume gambling in areas where legality exists.

Instead of ignoring this problem (and obtaining a result where the price coefficient will be biased away from zero [Grossman, Coate and Arluck (1987)]) market areas defined include the crossing of state boundaries. Methods used by other authors include choosing an arbitrary distance around the individual's area of residence could be delineated and the lowest price in that area would be the relevant price the individual faces [Lewit and Coate (1982)]. A second method is to use a weighted average of these two prices, where the weights are chosen arbitrarily. A third possibility is to enter the two prices separately [Lewit, Coate, and Grossman (1981)] or to enter the local price and the difference between

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the local price and the lowest price within some arbitrarily chosen distance. This final alternative provides the most information. The choice of prices becomes more important when the demand equations are estimated using leads and/or lags of the gambling price. Using the price - price differences specification will result in two additional variables for each lead or lag used, and, since they are likely to be highly correlated, problems of multicollinearity may be introduced.

The dependent variable in the equations estimated below is the real average per attendant track handle. Although this variable is measured in discrete terms, it will be treated as a continuous variable. Other dependent variables such as real average per capita track handle, and average per capita attendance will be considered.

Recall the alternative demand specifications above:

$$(1)\quad C(t) = \beta_0 + \beta_1 P_c(t) + \beta_2 P_c(t-1) + \beta_3 P_c(t+1) + \beta_4 C(t-1) + \beta_5 C(t+1)\quad ,$$

$$(2)\quad C(t) = \Gamma_0 + \Gamma_1 P_c(t) + \Gamma_2 C(t-1) + \Gamma_3 C(t+1)$$

and:

$$(3)\quad C(t) = \Theta_0 + \Theta_1 P_c(t) + \Theta_2 P_c(t+1) + \Theta_3 C(t+1) + \Theta_4 A(t)$$

To estimate the first two gambling demand equations, information on gambling consumption in three consecutive periods is required. To estimate the third demand equation, information on current, future and all past consumption is required.

The measures of lagged, current and led consumption used

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in the estimates of equation (1) and (2) were constructed as follows. Current consumption C(t) is the amount consumed during the year, C(t+1) is the amount consumed in the subsequent year, and C(t-1) is the amount consumed in the prior year. Current price, P(t), is the takeout rate during the year, future price, P(t+1) is the takeout rate in the subsequent year, and lagged price P(t-1) is the takeout rate in the prior year. These demand equations were then estimated using instrumental variables for C*(t+1) and C*(t-1). The instruments consist of four lags and leads of the price of bets.

To estimate equation (3), in addition to measures of current and future gambling consumption, some measure of the depreciated sum of all past consumption is required. To obtain a measure of the addictive stock at time t, recall its definition:

$$(4) \quad A(t) = C(t-1) + (1-\delta)A(t-1)$$

or,

$$(5) \quad A(t) = \Sigma_{i=0}^{t-1} (1-\delta)^{t-1-i} C(i) + A_0 .$$

Assuming the initial stock (A_0) is zero for all tracks, defining the depreciation term $(1-\delta)^{t-1-i}$ as D(i) and recalling the definition of the covariance between the depreciation term and gambling consumption, the following equation for the addictive stock is obtained:

$$(6) \quad A(t) = tCD + tCov[D(i),C(i)]$$
$$= C\ [(1-(1-\delta)^{t})/\delta] + tCov(D(i),C(i)]\ ,$$

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where a bar over the variables D and C indicates the mean of the depreciation term and gambling consumption, respectively. The covariance term above is assumed to equal zero. This is reasonable if gambling consumption changes relatively little. Making this assumption results in an estimate of the addictive stock which depends on the number of years since gambling began, gambling over that time, and the rate of depreciation on the addictive stock. Therefore, to obtain estimates of the addictive stock, data on average gambling consumption during the period, and the rate of depreciation on the addictive stock are required. Average gambling consumption is a collected variable, so all that remains to construct the addictive stock variable is the rate of depreciation on the stock. Different rates of depreciation on the stock ranging from ten to one hundred percent will be assumed with the results presented below, along with a discussion of the sensitivity of the results to changes in the assumed rate of depreciation.

The following pages describe the variables used in estimating the demand equations. The demand equations estimated for this dissertation are for horse tracks only. The means and standard deviations are for this subset of data only.

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Table 7-3

DEPENDENT VARIABLES

ATTPCAP	Attendance per capita -- total paid attendance during the meet year divided by the population of the track market area. $\mu = 1.59$, $\sigma = 0.17$
LGA1	Attendance per capita, one lag -- total paid attendance during the preceding meet year divided by the population of the track market area in the preceding year. $\mu = .160$, $\sigma = .17$
LA1	Attendance per capita, one lead -- total paid attendance during the following meet year divided by the population of the track market area in the following year. $\mu = .160$, $\sigma = .17$
RPCAPHAN	Real Average handle per capita -- total handle in 1967 dollars during the meet year divided by the population of the track market area. $\mu = 9.052$, $\sigma = 10.25$
LGB1	Real Average handle per capita, one lag -- total real handle during the preceding meet year divided by the population of the track market area in the preceding year. $\mu = 9.210$, $\sigma = 10.34$
LB1	Real Average handle per capita, one lead -- total real handle during the following meet year divided by the population of the track market area in the following year. $\mu = 9.113$, $\sigma = 10.16$

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Table 7-3 Dependent Variables -- continued

RPERATTH	Real Average handle per attendant -- total handle in 1967 dollars during the meet year divided by the total paid attendance. $\mu = 58.854$, $\sigma = 23.68$
LGC1	Real Average handle per attendant, one lag -- total real handle during the preceding meet year divided by the total paid attendance in the preceding year. $\mu = 59.571$, $\sigma = 23.62$
LC1	Real Average handle per attendant, one lead -- total real handle during the following year divided by the total paid attendance in the following year. $\mu = 58.861$, $\sigma = 23.49$

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Table 7-4

INDEPENDENT VARIABLES

	RACING INDUSTRY
RACES	Races -- number of races held during the meet year. $\mu = 537.210$, $\sigma = 487.98$
D1	Greyhound track -- dichotomous variable which takes the value 1 if the track is a greyhound track and 0 otherwise.
TO1	Takeout rate -- state legislated takeout rate for win place or show bets. $\mu = 15.255$, $\sigma = 2.03$
LGTO11	Takeout rate, one lag -- state legislated takeout rate for win place or show bets in the preceding year. $\mu = 15.191$, $\sigma = 2.03$
LGTO12	Takeout rate, two lags -- state legislated takeout rate for win place or show bets two years earlier. $\mu = 15.129$, $\sigma = 2.02$
LGTO13	Takeout rate, three lags -- state legislated takeout rate for win place or show bets three years earlier. $\mu = 15.071$, $\sigma = 2.00$
LGTO14	Takeout rate, four lags -- state legislated takeout rate for win place or show bets four years earlier. $\mu = 15.013$, $\sigma = 2.00$
LTO11	Takeout rate, one leads -- state legislated takeout rate for win place or show bets in the following year. $\mu = 15.325$, $\sigma = 1.99$

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Table 7-4 Independent Variables -- continued

LTO12	Takeout rate, two leads -- state legislated takeout rate for win place or show bets two years later. $\mu = 15.399$, $\sigma = 1.94$
LTO13	Takeout rate, three leads -- state legislated takeout rate for win place or show bets three years later. $\mu = 15.477$, $\sigma = 1.88$
LTO14	Takeout rate, four leads -- state legislated takeout rate for win place or show bets fcur years later. $\mu = 15.549$, $\sigma = 1.85$
TO2	Takeout rate 2 -- state legislated takeout rate for multiple race bets (2 to 4 horses). $\mu = 20.093$, $\sigma = 1.87$
LGTO21	Takeout rate 2, one lag -- state legislated takeout rate for multiple race bets (2 to 4 horses) in the preceding year. $\mu = 20.068$, $\sigma = 1.88$
LGTO22	Takeout rate 2, two lags -- state legislated takeout rate for multiple race bets (2 to 4 horses) two years earlier. $\mu = 20.036$, $\sigma = 1.90$
LGTO23	Takeout rate 2, three lags -- state legislated takeout rate for multiple race bets (2 to 4 horses) three years earlier. $\mu = 20.091$, $\sigma = 1.97$
LGTO24	Takeout rate 2, four lags -- state legislated takeout rate for multiple race bets (2 to 4 horses) four years earlier. $\mu = 20.225$, $\sigma = 2.04$

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Table 7-4 Independent Variables -- continued

LTO21	Takeout rate 2, one lead -- state legislated takeout rate for multiple race bets (2 to 4 horses) in the following year. $\mu = 20.093$, $\sigma = 1.87$
LTO22	Takeout rate 2, two leads -- state legislated takeout rate for multiple race bets (2 to 4 horses) two years later. $\mu = 20.096$, $\sigma = 1.87$
LTO23	Takeout rate 2, three leads -- state legislated takeout rate for multiple race bets (2 to 4 horses) three years later. $\mu = 20.105$, $\sigma = 1.87$
LTO24	Takeout rate 2, four leads -- state legislated takeout rate for multiple race bets (2 to 4 horses) four years later. $\mu = 20.113$, $\sigma = 1.88$
TO3	Takeout rate 3 -- state legislated takeout rate for exotic bets (5 or more horses). $\mu = 24.979$, $\sigma = 2.39$
LGTO31	Takeout rate 3, one lag -- state legislated takeout rate for exotic bets (5 or more horses) in the preceding year. $\mu = 24.892$, $\sigma = 1.95$
LGTO32	Takeout rate 3, two lags -- state legislated takeout rate for exotic bets (5 or more horses) two years earlier. $\mu = 24.771$, $\sigma = 1.04$
LGTO33	Takeout rate 3, three lags -- state legislated takeout rate for exotic bets (5 or more horses) three years earlier. $\mu = 24.907$, $\sigma = 0.72$

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Table 7-4 Independent Variables -- continued

LGTO34	Takeout rate 3, four lags -- state legislated takeout rate for exotic bets (5 or more horses) four years earlier. μ = 25.000, σ = 0.00
LTO31	Takeout rate 3, one lead -- state legislated takeout rate for exotic bets (5 or more horses) in the following year. μ = 24.979, σ = 2.40
LTO32	Takeout rate 3, two leads -- state legislated takeout rate for exotic bets (5 or more horses) two years later. μ = 24.979, σ = 2.41
LTO33	Takeout rate 3, three leads -- state legislated takeout rate for exotic bets (5 or more horses) three years later. μ = 24.979, σ = 2.42
LTO34	Takeout rate 3, four leads -- state legislated takeout rate for exotic bets (5 or more horses) four years later. μ = 24.979, σ = 2.42
ASTOCK10	Addictive Stock δ = 10% -- Depreciated sum of past attendance per capita calculated with an assumed rate of depreciation of ten percent. μ = 1.05, σ = 1.29
BSTOCK10	Addictive Stock δ = 10% -- Depreciated sum of past handle per capita calculated with an assumed rate of depreciation of ten percent. μ = 66.87, σ = 79.49

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Table 7-4 Independent Variables -- continued

CSTOCK10	Addictive Stock δ = 10% -- Depreciated sum of past handle per attendant calculated with an assumed rate of depreciation of ten percent. $\mu = 394.25$, $\sigma = 238.04$
ASTOCK20	Addictive Stock δ = 20% -- Depreciated sum of past attendance per capita calculated with an assumed rate of depreciation of twenty percent. $\mu = 0.63$, $\sigma = 0.72$
BSTOCK20	Addictive Stock δ = 20% -- Depreciated sum of past handle per capita calculated with an assumed rate of depreciation of twenty percent. $\mu = 39.30$, $\sigma = 45.15$
CSTOCK20	Addictive Stock δ = 20% -- Depreciated sum of past handle per attendant calculated with an assumed rate of depreciation of twenty percent. $\mu = 236.67$, $\sigma = 125.93$
ASTOCK30	Addictive Stock δ = 30% -- Depreciated sum of past attendance per capita calculated with an assumed rate of depreciation of thirty percent. $\mu = 0.45$, $\sigma = 0.50$
BSTOCK30	Addictive Stock δ = 30% -- Depreciated sum of past handle per capita calculated with an assumed rate of depreciation of thirty percent. $\mu = 27.59$, $\sigma = 31.62$

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Table 7-4 Independent Variables -- continued

CSTOCK30	Addictive Stock δ = 30% -- Depreciated sum of past handle per attendant calculated with an assumed rate of depreciation of thirty percent. μ = 167.36, σ = 84.79
ASTOCK40	Addictive Stock δ = 40% -- Depreciated sum of past attendance per capita calculated with an assumed rate of depreciation of forty percent. μ = 0.35, σ = 0.39
BSTOCK40	Addictive Stock δ = 40% -- Depreciated sum of past handle per capita calculated with an assumed rate of depreciation of forty percent. μ = 21.21, σ = 24.36
CSTOCK40	Addictive Stock δ = 40% -- Depreciated sum of past handle per attendant calculated with an assumed rate of depreciation of forty percent. μ = 129.13, σ = 64.13
ASTOCK50	Addictive Stock δ = 50% -- Depreciated sum of past attendance per capita calculated with an assumed rate of depreciation of fifty percent. μ = 0.28, σ = 0.32
BSTOCK50	Addictive Stock δ = 50% -- Depreciated sum of past handle per capita calculated with an assumed rate of depreciation of fifty percent. μ = 17.21, σ = 24.36

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Table 7-4 Independent Variables -- continued

CSTOCK50	Addictive Stock δ = 50% -- Depreciated sum of past handle per attendant calculated with an assumed rate of depreciation of fifty percent. μ = 105.03, σ = 51.83
ASTOCK60	Addictive Stock δ = 60% -- Depreciated sum of past attendance per capita calculated with an assumed rate of depreciation of sixty percent. μ = 0.24, σ = 0.27
BSTOCK60	Addictive Stock δ = 60% -- Depreciated sum of past handle per capita calculated with an assumed rate of depreciation of sixty percent. μ = 14.47, σ = 16.71
CSTOCK60	Addictive Stock δ = 60% -- Depreciated sum of past handle per attendant calculated with an assumed rate of depreciation of sixty percent. μ = 88.48, σ = 43.72
ASTOCK70	Addictive Stock δ = 70% -- Depreciated sum of past attendance per capita calculated with an assumed rate of depreciation of seventy percent. μ = 0.21, σ = 0.23
BSTOCK70	Addictive Stock δ = 70% -- Depreciated sum of past handle per capita calculated with an assumed rate of depreciation of seventy percent. μ = 12.48, σ = 14.45

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Table 7-4 Independent Variables -- continued

CSTOCK70	<u>Addictive Stock δ = 70%</u> -- Depreciated sum of past handle per attendant calculated with an assumed rate of depreciation of seventy percent. μ = 76.43, σ = 38.02
ASTOCK80	<u>Addictive Stock δ = 80%</u> -- Depreciated sum of past attendance per capita calculated with an assumed rate of depreciation of eighty percent. μ = 0.18, σ = 0.20
BSTOCK80	<u>Addictive Stock δ = 80%</u> -- Depreciated sum of past handle per capita calculated with an assumed rate of depreciation of eighty percent. μ = 10.98, σ = 12.74
CSTOCK80	<u>Addictive Stock δ = 80%</u> -- Depreciated sum of past handle per attendant calculated with an assumed rate of depreciation of eighty percent. μ = 67.26, σ = 33.82
ASTOCK90	<u>Addictive Stock δ = 90%</u> -- Depreciated sum of past attendance per capita calculated with an assumed rate of depreciation of ninety percent. μ = 0.16, σ = 0.18
BSTOCK90	<u>Addictive Stock δ = 90%</u> -- Depreciated sum of past handle per capita calculated with an assumed rate of depreciation of ninety percent. μ = 9.79, σ = 11.40

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Table 7-4 Independent Variables -- continued

CSTOCK90	Addictive Stock δ = 90% -- Depreciated sum of past handle per attendant calculated with an assumed rate of depreciation of ninety percent. $\mu = 60.06$, $\sigma = 30.65$
EXOTIC	Exotic betting available -- dichotomous variable which takes the value 1 if exotic betting (5 or more horses or races) is available at the track and 0 otherwise. $\mu = 0.074$, $\sigma = 0.26$
MUL	Multiple betting available -- dichotomous variable which takes the value 1 if multiple betting (2 - 4 horses or races) is available at the track and 0 otherwise. $\mu = 0.201$, $\sigma = 0.40$
	LOTTERY VARIABLES
LOT	Lottery existence -- dichotomous variable which takes the value 1 if the state has an operating lottery and 0 otherwise. $\mu = 0.163$, $\sigma = 0.37$
LOTBETT	Real Per Capita Wagering on Lotteries -- average real per capita bet on combined total of all lottery games in the state where the track is located. $\mu = 17.464$, $\sigma = 12.721$
LOTBETI	Real Per Capita Wagering on Instant Lotteries -- average real per capita bet on instant lotteries in the state where the track is located. $\mu = 5.017$, $\sigma = 4.50$

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Table 7-4 Independent Variables -- continued

LOTBET3	Real Per Capita Wagering on Pick 3 Games -- average real per capita bet on Pick 3 games in the state where the track is located. $\mu = 12.429$, $\sigma = 9.63$
LOTBET4	Real Per Capita Wagering on Pick 4 Games -- average real per capita bet on Pick 4 games in the state where the track is located. $\mu = 2.664$ $\sigma = 2.24$
LOTBETL	Real Per Capita Wagering on Lotto -- average real per capita bet on Lotto in the state where the track is located. $\mu = 6.280$ $\sigma = 5.52$
FIRSTYR	First year lottery -- dichotomous variable which takes the value 1 if the state has an operating lottery in its first year of operation and 0 otherwise. $\mu = 0.200$, $\sigma = 0.14$
	DEMOGRAPHIC VARIABLES
RPCI	Real per capita income -- average real per capita income of the track market area in 1967 dollars. $\mu = 2931.894$, $\sigma = 869.96$
WHITE	Fraction of the population that is white -- total white population in the track market area divided by the total population of the track market area. $\mu = 0.883$, $\mu = 0.08$
MEDTOT	Median educational level -- median years of education level attained in the track market area. $\mu = 11.473$, $\sigma = 1.13$

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Table 7-4 Independent Variables -- continued

URBAN	Fraction of the population living in an urban area -- urban population in the track market area divided by the total population in the market area. μ = 0.712, σ = 0.22
	STRESS VARIABLES
UNEMP	Unemployment rate -- average unemployment rate (in percentage points) of the state in which the track is located. μ = 5.862, σ = 2.29
DIVORCE	Divorce rate -- percentage of women ages 25-34 who are divorced in the state in which the track is located. μ = 5.603, σ = 3.22
	RELIGION VARIABLES
PROTH	Protestant -- percentage of the population in the state where the track is located which is Protestant (other than Mormon or Southern Baptist). μ = 19.655, σ = 8.11
LDSAINT	Mormon -- percentage of the population in the state where the track is located which is Mormon (Latter Day Saints). μ = 0.995, σ = 2.66
SOBAPT	Southern Baptist -- percentage of the population in the state where the track is located which is Southern Baptist. μ = 3.624, σ = 6.08

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Table 7-4 Independent Variables -- continued

CATHOLIC	Catholic -- percentage of the population in the state where the track is located who are Catholic. $\mu = 23.45$, $\sigma = 12.29$
	OTHER VARIABLES
D50--D87	Time dummy -- dichotomous variable to identify years 1950 through 1987
T1--T207	Track dummy -- dichotomous variable to identify tracks.

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Chapter Eight

Results from the Estimation of the Basic Models

This chapter contains the results from the estimation of the demand equations derived in Chapter Six. The results of the demand equations under the assumption of non-addictive behavior are presented first. The demand equations under the assumption of addictive behavior are then presented. Price elasticities of demand for each of the demand equations follow.

The results obtained for the demand equations under the assumption that gambling is a non-addictive behavior are presented in Tables 8-1 through 8-6. These results are comparable to much of the prior research on gambling demand and offer an interesting comparison to the results obtained for equations estimated under the competing hypothesis that gambling is an addictive behavior.

Consumption in each of the equations is assumed to be a function of the current price of gambling, the number of races, and real per capita income. Then two specifications are used to measure the specific track market area effects since track market areas differ in demographic composition, income and other variables correlated with gambling. In the first specification, dichotomous variables for each track except one are used to estimate each model. In the second specification, the models are estimated replacing the dichotomous variables for each track except one with

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demographic variables. The demographic variables include the fraction of the population that is white, the divorce rate, the unemployment rate and the median educational attainment of the track market areas are used to estimate the models. These variables are too collinear with the track dummies to be included in the same regression.

Time specific dummy variables have been incorporated into all model specifications. These have been added primarily to incorporate the increased availability of gambling to the population through the proliferation of state lotteries, increasing number of pari-mutuel outlets, and casinos. Also, the incidence of illegal betting has changed over time and no specific measure of this activity is available. Furthermore, if gambling is a leisure activity or spectator sport, the availability of substitutes (such as professional sports teams, cable television and videocassettes) has changed over time.

Gambling consumption at time t, in every model, addictive or non-addictive is expected to be negatively related to the price of gambling in time t.

There is no a priori expectations about the sign of income, the unemployment rate, the divorce rate, or educational attainment. Other studies have shown positive income effects for the average per capita bet and average per attendant bet and negative income effects on attendance. However, recent literature has focused on the fact that lower

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income people bet a higher proportion of their incomes (especially in the case of lotteries). Because the data are aggregate, the way income will affect the consumption of gambling is unclear.

Other studies have indicated that the proportion of the population that is black has a positive effect on the average bet per attendant. No study has use the fraction of the population that is white as an explanatory variable. Even though the fraction of the population that is white and the fraction of the population that is black do not sum to one (due to the presence of other non-white groups) it is expected that there will be a negative relationship.

The unemployment rate could be considered a stress variable and would therefore have a positive effect on gambling. It could also be considered a proxy for the value of time and would have a positive effect on gambling. Other studies have shown that unemployment has a negative effect on attendance.

The divorce rate could also be considered a stress variable which may indicate a positive relationship to gambling. No other studies have included the divorce rate as an explanatory variable.

Education attainment could have a negative relationship to gambling if it creates greater knowledge of the mathematical odds of winning and cause people not to gamble. On the other hand, it may serve to better prepare people to

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correctly assess (or handicap) various races. Therefore, the direction of education's effect is unclear. No other study has used education as an explanatory variable.

Table 8-1 contains the estimates from the estimation of the demand equations where the dependent variable is the fraction of the track market area attending the track or ATTENDANCE PER CAPITA. Table 8-4 contains the OLS estimates of the reduced form of the equations which include the lag and lead prices as explanatory variables for attendance per capita.

Table 8-2 contains the estimates from the estimation of the demand equations where the dependent variable is the real handle divided by the population of the track market area or HANDLE PER CAPITA. Table 8-5 contains the OLS estimates of the reduced form of the equations which include the lag and lead prices as explanatory variables for handle per capita.

Table 8-3 contains the estimates from the estimation of the demand equations where the dependent variable is the real handle divided by the attendance at the track or HANDLE PER ATTENDANT. Table 8-6 contains the OLS estimates of the reduced form of the equations which include the lag and lead prices as explanatory variables for handle per attendant.

The first two columns of each table show the results using dichotomous track and time variables and the associated t values. The third and fourth columns show the results using dichotomous time variables and demographic variables and the

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Table 8-1

OLS Estimates of Non-Addictive Gambling Demand Equations
Dependent Variable = Attendance Per Capita

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.013	-8.01	-0.003	-1.22
Future Price	-	-	-	-
Lagged Price	-	-	-	-
Income	-0.00001	-2.44	-0.0001	-14.57
Fraction White			-0.032	-0.77
Percent Divorced			0.005	2.34
Percent Unemployed			-0.010	-5.21
Median Education			-0.002	-0.25
Races	0.0001	21.02	0.001	20.43
R Squared	.883		.250	
F	111.807		25.149	

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Table 8-2

OLS Estimates of Non-Addictive Gambling Demand Equations
Dependent Variable = Real Handle Per Capita

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.527	-5.34	-0.263	-2.20
Future Price	-	-	-	-
Lagged Price	-	-	-	-
Income	-0.002	-5.39	-0.003	-8.75
Fraction White			-16.924	-7.42
Percent Divorced			0.420	3.27
Percent Unemployed			-0.712	-7.03
Median Education			0.113	0.33
Races	0.006	17.66	0.009	24.93
R Squared	.844		.223	
F	84.26		22.25	

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Table 8-3

OLS Estimates of Non-Addictive Gambling Demand Equations
Dependent Variable = Real Handle Per Attendant

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-1.750	-7.38	-1.544	-5.96
Future Price	-	-	-	-
Lagged Price	-	-	-	-
Income	-0.004	-4.98	0.013	18.06
Fraction White			-83.377	-18.03
Percent Divorced			-0.386	-1.49
Percent Unemployed			-0.576	-2.77
Median Education			-0.871	-1.20
Races	-0.001	-1.41	0.012	16.46
R Squared	.863		.502	
F	93.61		75.91	

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Table 8-4

OLS Estimates of Reduced Form of the Gambling Demand Equation
Truncated Form of the Addictive Model
Dependent Variable = Attendance Per Capita

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.003	-0.87	-0.00004	-0.005
Future Price	-0.007	-2.60	-0.013	-1.93
Lagged Price	-0.005	-2.04	0.012	1.95
Income	-0.00001	-2.68	-0.0001	-13.89
Fraction White			-0.023	-0.53
Percent Divorced			0.006	2.60
Percent Unemployed			-0.012	-5.92
Median Education			-0.002	-0.36
Races	0.0001	18.78	0.0001	19.45
R Squared	.891		.258	
F	118.83		23.79	

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Table 8-5

OLS Estimates of Reduced Form of the Gambling Demand Equation
Truncated Form of the Addictive Model
Dependent Variable = Real Handle Per Capita

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.149	-0.69	0.021	0.04
Future Price	-0.396	-2.33	-0.961	-2.64
Lagged Price	-0.170	-1.00	0.721	2.03
Income	-0.002	-5.30	-0.003	-8.45
Fraction White			-17.310	-7.18
Percent Divorced			0.471	3.44
Percent Unemployed			-0.813	-7.55
Median Education			0.123	0.34
Races	0.006	16.01	0.009	23.94
R Squared	.854		.226	
F	89.10		20.52	

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Table 8-6

OLS Estimates of Reduced Form of the Gambling Demand Equation
Truncated Form of the Addictive Model
Dependent Variable = Real Handle Per Attendant

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.867	-1.66	-0.479	-0.49
Future Price	-0.606	-1.44	-0.924	-1.22
Lagged Price	-0.725	-1.84	-0.126	-0.18
Income	-0.003	-3.89	0.013	17.19
Fraction White			-85.410	-17.68
Percent Divorced			-0.368	-1.35
Percent Unemployed			-0.843	-3.85
Median Education			-1.128	-1.49
Races	-0.001	-1.47	0.012	16.27
R Squared	.868		.501	
F	95.86		68.67	

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associated t values.

As expected, all dependent variables at time t are inversely related to the current price of gambling. The absolute value of the price effect is larger and more significant, for all dependent variables in the specifications using track and time dummies than for the specifications using time dummies and demographic variables.

Income has a negative and significant effect on all three dependent variables for the specification with track and time dummy variables. Income has a negative and significant effect on attendance per capita and handle per capita, and a positive and significant effect on the handle per attendant in the specification using time dummies and demographic variables. Other studies have shown income to negatively affect attendance, but positively effect handle per capita and handle per attendant. The results using the time dummies and demographic variables are consistent with the prior studies.

The number of races has a positive and significant effect on all three dependent variables in the specification with time dummies and demographic variables. The number of races has a positive and significant effect on attendance per capita and handle per attendant and a negative and significant effect on handle per attendant in the specifications using track and time dummies. Other studies show that the number of races increases attendance per capita and reduces handle per attendant. The results using the track and time dummies are

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consistent with the prior studies.

The fraction of the population that is white has a negative effect on all three dependent variables at time t, however, is not significant for attendance per capita.

The divorce rate has a positive and significant effect on attendance per capita and handle per capita and a negative but insignificant effect on handle per attendant.

The unemployment rate has a negative and significant effect on all three dependent variables. This is consistent with other studies.

Educational attainment has no significant effect on any of the three dependent variables. The coefficient is negative for attendance per capita and handle per attendant and positive for handle per capita.

The OLS estimates of the non-addictive model yield results consistent with prior studies on gambling. However, real handle per attendant is sensitive to the specification (using track and time dummies versus using time dummies and demographic variables) for races and income.

Adding a lag and lead of the price to the models yields similar results for the specification using track and time dummies. Lag and lead prices have a negative effect on the dependent variables at time t. The price at time t remains negative but loses significance. The results using the specification with time dummies and demographic variables yield similar results, however, the price effects are not

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stable. The price effects for attendance per capita and handle per attendant are less significantly negative and the price variable for the handle per capita becomes positive. Lagged price is positive and significant for attendance per capita and handle per capita.

The results of the demand equations estimated under the assumption that gambling is an addictive behavior are presented in Tables 8-7 through 8-45.

Tables 8-7, 8-8 and 8-9 which show the results for equations estimated assuming that the rate of depreciation on the addictive stock is one hundred percent. These are followed by Tables 8-10, 8-11 and 8-12 are for the demand equation where there is no assumed rate of depreciation on the addictive stock. This results in the inclusion of past and future prices in the equation.

All of the equations are estimated using the instrumental variables procedure due to the endogeneity of past and future consumption or the addictive stock and future consumption. Current consumption is specified as a function of one lag of consumption, one lead of consumption, lagged, current and future prices of gambling implying that the current consumption is independent of other past and future prices, suggesting that further lags and leads of prices are suitable instruments for lagged and led consumption. Similar arguments can be made for using several lags and leads of prices as instruments for the addictive stock and future consumption.

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Table 8-7

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Attendance Per Capita
Depreciation Rate = 100%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.0004	-0.23	-0.0003	-0.37
Future Price	-	-	-	-
Lagged Price	-	-	-	-
Future Consumption	0.622	3.21	0.548	3.21
Lagged Consumption	0.364	1.71	0.408	1.95
Income	-0.000001	-0.46	-0.000004	-0.97
Fraction White			0.002	0.19
Percent Divorced			0.0009	1.15
Percent Unemployed			-0.001	-1.46
Median Education			0.00003	0.02
Races	0.00004	5.46	0.00001	1.85
R Squared	.978		.924	
F	547.74		682.28	

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No restrictions in second stage

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Table 8-8

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Real Handle Per Capita
Depreciation Rate = 100%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.115	-1.44	0.061	1.97
Future Price	-	-	-	-
Lagged Price	-	-	-	-
Future Consumption	0.399	2.97	0.774	4.63
Lagged Consumption	0.562	3.34	0.151	0.83
Income	-0.0002	-1.26	-0.0001	-1.27
Fraction White			-1.957	-2.74
Percent Divorced			0.144	3.91
Percent Unemployed			-0.220	-6.28
Median Education			0.160	1.85
Races	0.002	3.31	0.001	4.32
R Squared	.981		.897	
F	713.47		514.83	

No restrictions in first stage
No restrictions in second stage

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Table 8-9

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Real Handle Per Attendant
Depreciation Rate = 100%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.711	-2.21	-0.168	-1.02
Future Price	-	-	-	-
Lagged Price	-	-	-	-
Future Consumption	0.289	1.65	0.434	2.76
Lagged Consumption	0.439	2.59	0.489	2.78
Income	-0.0005	-1.01	0.001	0.84
Fraction White			-7.505	-0.95
Percent Divorced			0.056	0.51
Percent Unemployed			-0.182	-1.25
Median Education			-0.137	-0.53
Races	-0.0007	-1.03	0.001	1.02
R Squared	.961		.936	
F	306.55		816.97	

No restrictions in first stage
No restrictions in second stage

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Table 8-10

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Attendance Per Capita
No Assumed Rate of Depreciation

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	0.0008	0.45	0.002	0.82
Future Price	-0.003	-1.27	-0.003	-1.16
Lagged Price	-0.0007	-0.42	-0.0003	-0.20
Future Consumption	0.369	1.29	0.305	1.10
Lagged Consumption	0.553	1.90	0.686	2.13
Income	-0.000002	-0.74	-0.000003	-0.69
Fraction White			-0.001	-0.12
Percent Divorced			0.0004	0.43
Percent Unemployed			-0.0008	-0.81
Median Education			0.0006	0.35
Races	0.00004	4.95	0.000008	1.01
R Squared	.979		.919	
F	558.35		598.52	

No restrictions in the first stage
No restrictions in the second stage

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Table 8-11

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Real Handle Per Capita
No Assumed Rate of Depreciation

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.091	-0.86	-0.038	-0.38
Future Price	-0.120	-0.94	-0.002	-0.02
Lagged Price	0.119	0.97	0.103	1.16
Future Consumption	0.137	0.52	0.706	2.62
Lagged Consumption	0.884	2.74	0.217	0.77
Income	-0.0001	-0.51	-0.0002	-1.39
Fraction White			-1.991	-2.82
Percent Divorced			0.143	3.79
Percent Unemployed			-0.225	-6.51
Median Education			0.147	1.65
Races	0.001	1.24	0.001	3.84
R Squared	.973		.902	
F	480.91		517.54	

No restrictions in first stage
No restrictions in second stage

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Table 8-12

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Real Handle Per Attendant
No Assumed Rate of Depreciation

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.724	-2.28	-0.666	-2.17
Future Price	0.094	0.23	0.148	0.50
Lagged Price	0.411	1.06	0.536	2.01
Future Consumption	0.346	1.24	0.352	1.57
Lagged Consumption	0.552	2.60	0.644	2.69
Income	-0.0003	-0.57	-0.00004	-0.03
Fraction White			-0.400	-0.05
Percent Divorced			0.113	0.92
Percent Unemployed			-0.087	-0.57
Median Education			-0.164	-0.61
Races	-0.0004	-0.48	0.00008	0.06
R Squared	.964		.936	
F	331.57		774.63	

No restrictions in first stage
No restrictions in second stage

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The set of instruments employed includes the exogenous variables affecting consumption, four lags of price, four leads of price and the current price.

Looking at the demographic variables in the specification using time dummies along with demographic variables may lead one to conclude that none are significant determinants of demand. With few exceptions, the coefficients on these variables are statistically insignificant. Given the importance of each of these in the equations estimated under the assumption of non-addictive behavior presented above, it seems unwise to reject them entirely. Whenever one of the variables is included as a determinant of current consumption, it is also included in the set of instruments employed for future and past consumption. Much of the impact of these variables may be captured indirectly through their roles in determining both pas and future consumption. The findings for income, the number of races, the fraction of the population that is white, the divorce rate, the unemployment rate, and educational attainment are similar to those obtained in the non-addictive models. These results are the fraction of the population that is white negatively affects consumption, the divorce rate positively affects consumption, the unemployment rate negatively affects consumption, educational attainment negatively affects consumption. Income continues to have a negative effect on the consumption of all three dependent variables in all specifications except for the handle per

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attendant in the specification with time and demographic variables. The number of races has a positive effect for all three dependent variables in at least one specification of the model. However the number of races has a negative but insignificant effect on attendance per capita in the specification with time dummies and demographic variables and in the handle per attendant in the specification with track and time dummies.

Before discussing the results obtained for the key variables, gambling prices, future consumption, past consumption and the addictive stock, a brief review of the implications of the model of rational addiction is in order. In every model, gambling consumption should be inversely related to the current price of gambling. When they are included, past and future prices should positively affect current consumption, even though past and future consumption are complementary with current consumption when behavior is addictive. However, controlling for past consumption eliminates the channel through which the past prices affect current consumption. But the only way that past consumption stays fixed when past prices are higher would be for another force to offset higher past prices by raising the past stock of consumption capital. Since this higher value of the stock continues into the present period (reduced only by depreciation), current consumption must be higher when past prices are higher. This also explains why past and future

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prices were not in the estimating equation of the simple model. That model implies a depreciation rate of one hundred percent, so that any larger past stock is eliminated entirely by depreciation.

In the model with no assumed rate of depreciation on the addictive stock, the effect of future price on current consumption should be less than the effect of past price on current consumption by a factor of $1/(1+\sigma)$. The absolute value of the effect of current price on consumption should be larger than the combined effects of past and future price on current consumption, holding past and future consumption constant. The comparable expectation in the stock models is that the absolute value of the effect of future price on current consumption will be less than the impact of current price on current consumption by the term $(1-\delta)/(1+\sigma)$.

Adjacent complementarity is one of Becker and Murphy's requirements for addiction. This implies that a positive relationship exists between consumption in consecutive periods. Therefore, future consumption, and when it enters, past consumption should have a positive influence on current consumption. On the other hand, in the models which include the stock of past consumption, no a priori predictions can be made concerning the direction of the relationship between the stock and current consumption due to the offsetting effects of reinforcement in consumption and the full price of gambling being captured by the addictive stock. When both future and

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past consumption enter, the effect of past consumption is expected to be larger than the effect of future consumption by the factor of $(1+\sigma)$. For stability of the second order difference equations, the sum of the effects of past and future consumption should be less than one. The comparable condition for the stock models is that the sum of the coefficients on future consumption plus the coefficient on the stock divided by the assumed rate of depreciation should be less than one.

In examining the models with no assumed rate of depreciation, only handle per attendant yields results conforming to the predictions of the model. In both specifications of the model, current consumption is found to be significantly negatively related to the current price of gambling. Similarly, past and future prices have the anticipated positive effect, however they are not significant, except for lagged price in the specification with time dummies and demographic variables. In both specifications, past consumption has positive and significant effect on current consumption, future consumption is positive, however is insignificant. An F test was done to determine whether future consumption and future price are jointly equal to zero. The results allow the rejection that future consumption and future price are jointly equal to zero.

The results for handle per capita yield an insignificant negative coefficient on price. Lagged price has a positive

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effect on current consumption, however is insignificant. The future price has a negative but insignificant effect on current consumption. In the specification with track and time dummies, lagged consumption and future consumption have positive effects on current consumption, but only lagged consumption is significant. The coefficient of the lagged consumption is larger than the coefficient for future consumption only in the specification with track and time dummies.

The results for attendance per capita, price yields a positive, however insignificant, effect on current consumption in both specifications. Lagged and future price have negative effects on current consumption in both specification however are insignificant. Lagged and future consumption have positive effects on current consumption in both specifications, however, lagged consumption is significant and future consumption is not. The coefficient of lagged consumption is larger than future consumption in both specifications.

Since the specification with track and time dummies is more stable with regard to price and consumption effects, this will be the only specification considered from this point, unless noted.

In the models where the rate of depreciation on the addictive stock is assumed to be one hundred percent, the coefficients of price are significant for handle per

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attendant, and handle per capita (7.5%), however are insignificant for attendance per capita. Lagged and future consumption are positive and significant for handle per capita. Lagged and future consumption (5%) is significant for handle per attendant. Both handle per capita and handle per attendant have the coefficient of lagged consumption larger than the coefficient of future consumption. The future consumption of handle per capita is deemed to be .71 of lagged consumption (σ = .41). The future consumption of handle per attendant is deemed to be .66 of lagged consumption (σ = .52). From these results, no further consideration of attendance per capita as an addictive behavior is given.

It is not surprising that the coefficients on price fail to achieve statistical significance at higher levels given the high correlation between prices in consecutive periods and the use of the gambling prices as instruments for past and future consumption. The combination of these factors is likely to result in substantial multicollinearity between the gambling prices and the measures of past and future consumption, a problem which leads to inflated standard errors for the coefficients on these variables and, hence to less statistically significant results. One approach to this problem is to impose the restrictions suggested by the model. In particular, while estimating equation (31), the restriction could be imposed that the coefficient on future price and future consumption be smaller by the factor $1 / (1 + \sigma)$ than

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the coefficients on past price and past consumption respectively. Similarly, when estimating equation (47), the restriction that the coefficient of future price be equal to the coefficient on current price multiplied by the factor $-(1 - \delta) / (1 + \sigma)$ could be imposed.

Tables 8-13 and 8-14 contain estimates of the demand equation when consumption only is restricted in the second stage. Tables 8-15 and 8-16 contain estimates of the demand equations when both price and consumption are restricted in the second stage. Tables 8-17 and 8-18 contain the estimates of the demand equations when price is restricted in the first stage and price and restriction are restricted in the second stage. None of the restrictions imposed on handle per capita has a significant effect on the sum of squared errors implying that the restrictions are valid, for the specification with track and time dummies. The restrictions are not valid for the specification that uses demographic variables and time dummies.

None of the restrictions imposed on per attendant handle has a significant effect on the sum of squared errors, implying that the restrictions are valid for both specifications of the model. The main result of the imposition of the linear restrictions is that the statistical significance of the price and consumption coefficients is improved this leading to more significant estimates of long run price elasticity of demand.

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Table 8-13

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Real Handle Per Capita
Depreciation Rate = 100%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.115	-1.45	0.031	1.24
Future Price	-	-	-	-
Lagged Price	-	-	-	-
Future Consumption	0.399	10.00	0.398	44.85
Lagged Consumption	0.562	10.00	0.560	44.85
Income	-0.0002	-1.31	-0.0002	-1.51
Fraction White			-1.385	-2.34
Percent Divorced			0.114	3.74
Percent Unemployed			-0.196	-6.63
Median Education			0.094	1.30
Races	0.002	3.90	0.0008	4.30
Restriction t's Consumption		-0.001		2.54
R Squared	.981		.917	
F	718.74		673.81	

No restrictions in first stage
Consumption restricted in second stage

Beta=.71

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Table 8-14

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Real Handle Per Attendant
Depreciation Rate = 100%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.711	-2.23	-0.149	-0.94
Future Price	-	-	-	-
Lagged Price	-	-	-	-
Future Consumption	0.290	5.84	0.369	11.54
Lagged Consumption	0.439	5.84	0.560	11.54
Income	-0.0005	-1.01	0.0008	0.77
Fraction White			-6.763	-0.88
Percent Divorced			0.085	0.99
Percent Unemployed			-0.180	-1.24
Median Education			-0.172	-0.71
Races	-0.0007	-1.21	0.001	0.94
Restriction t's Consumption		-0.002		0.42
R Squared	.961		.936	
F	308.90		839.34	

No restrictions in first stage
Consumption restricted in second stage

Beta=.66

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Table 8-15

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Real Handle Per Capita
No Assumed Rate of Depreciation

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.125	-1.45	-0.043	-0.48
Future Price	0.019	0.32	0.033	0.85
Lagged Price	0.026	0.32	0.046	0.85
Future Consumption	0.414	6.70	0.397	44.61
Lagged Consumption	0.583	6.70	0.559	44.61
Income	-0.0002	-0.79	-0.0002	-1.51
Fraction White			-1.409	-2.38
Percent Divorced			0.115	3.77
Percent Unemployed			-0.199	-6.67
Median Education			0.091	1.25
Races	0.002	2.36	0.0009	4.34
Restriction t's				
Consumption		-0.06		2.73
Prices		-0.93		-2.46
R Squared	.981		.917	
F	691.67		653.52	

No restrictions in first stage
Consumption and prices restricted in second stage

Beta=.71

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Table 8-16

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Real Handle Per Attendant
No Assumed Rate of Depreciation

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.761	-2.46	-0.710	-2.47
Future Price	0.210	0.91	0.292	2.33
Lagged Price	0.318	0.91	0.442	2.33
Future Consumption	0.354	4.19	0.398	11.76
Lagged Consumption	0.536	4.19	0.603	11.76
Income	-0.0003	-0.57	-0.00008	-0.07
Fraction White			-0.040	-0.005
Percent Divorced			0.101	1.20
Percent Unemployed			-0.076	-0.50
Median Education			-0.143	-0.60
Races	-0.0004	-0.67	0.00005	0.04
Restriction t's				
Consumption		0.35		0.26
Prices		-0.57		-0.56
R Squared	.965		.838	
F	337.75		838.55	

No restrictions in first stage
Consumption and price restricted in second stage

Beta=.66

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Table 8-17

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Real Handle Per Capita
No Assumed Rate of Depreciation

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.122	-1.41	-0.037	-0.41
Future Price	0.023	0.38	0.032	0.82
Lagged Price	0.032	0.38	0.045	0.82
Future Consumption	0.419	6.70	0.400	44.56
Lagged Consumption	0.590	6.70	0.564	44.56
Income	-0.0002	-0.70	-0.0001	-1.26
Fraction White			-1.311	-2.20
Percent Divorced			0.113	3.69
Percent Unemployed			-0.197	-6.61
Median Education			0.096	1.32
Races	0.002	2.25	0.0008	4.02
Restriction t's				
Consumption		-0.57		1.21
Prices		-0.25		3.00
R Squared	.980		.917	
F	681.42		652.87	

Price restricted in first stage
Consumption and price restricted in second stage

Beta=.71

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Table 8-18

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Real Handle Per Attendant
No Assumed Rate of Depreciation

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.749	-2.42	-0.707	-2.46
Future Price	0.233	1.01	0.295	2.35
Lagged Price	0.353	1.01	0.446	2.35
Future Consumption	0.364	4.29	0.400	11.78
Lagged Consumption	0.551	4.29	0.606	11.78
Income	-0.0002	-0.51	-0.0001	-0.13
Fraction White			0.430	0.05
Percent Divorced			0.103	1.21
Percent Unemployed			-0.068	-0.45
Median Education			-0.140	-0.58
Races	-0.0004	-0.60	-0.00002	-0.02
Restriction t's				
Consumption		-0.02		-0.22
Prices		-0.19		-0.06
R Squared	.968		.937	
F	338.53		835.47	

Price restricted in first stage
Consumption and price restricted in second stage

Beta=.66

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As with gambling prices, all of the predictions concerning the magnitudes and directions of the effects of past and future consumption on current consumption are supported by the estimates presented above. As noted earlier, the Becker-Grossman-Murphy test for addiction, in at least an economic sense, is that past consumption has a significant positive effect on current consumption. In each of the models estimated including past consumption as a determinant of current consumption, positive coefficients significant at least the one percent level are obtained.

All estimates of prices and intertemporal linkages in consumption for handle per attendant conform to the predictions of the model. In the estimation of handle per capita, the sum of the coefficients of past and future consumption is very close to one or greater than one. This causes the long run price elasticity to be positive.

Tables 8-19, 8-20 and 8-21 show the results for equations estimated assuming that the rate of depreciation on the addictive stock is ten percent. Tables 8-22, 8-23 and 8-24 show the results for equations estimated assuming that the rate of depreciation on the addictive stock is twenty percent. Tables 8-25, 8-26 and 8-27 show the results for equations estimated assuming that the rate of depreciation on the addictive stock is thirty percent. Tables 8-28, 8-29 and 8-30 show the results for equations estimated assuming that the rate of depreciation on the addictive stock is forty percent.

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Tables 8-31, 8-32 and 8-33 show the results for equations estimated assuming that the rate of depreciation on the addictive stock is fifty percent. Tables 8-34, 8-35 and 8-36 show the results for equations estimated assuming that the rate of depreciation on the addictive stock is sixty percent. Tables 8-37, 8-38 and 8-39 show the results for equations estimated assuming that the rate of depreciation on the addictive stock is seventy percent. Tables 8-40, 8-41 and 8-42 show the results for equations estimated assuming that the rate of depreciation on the addictive stock is eighty percent. Tables 8-43, 8-44 and 8-45 show the results for equations estimated assuming that the rate of depreciation on the addictive stock is ninety percent. These result in the exclusion of past consumption and past price from the equation and the addition of the depreciated addictive stock to the equations.

In the stock models for handle per attendant, the coefficients for current price are negative at all depreciation rates and they become most significant with depreciation rates around fifty percent and become less significant as the depreciation rates get higher or lower (but they are significant at least at the five percent level). The coefficients on future price are positive but insignificant at all depreciation rates. The coefficients on future price are positive and have the most significance at depreciation rates around forty percent and become less significant as the

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Table 8-19

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Attendance Per Capita
Depreciation Rate = 10%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.002	-0.72	-0.0006	-0.22
Future Price	-0.0008	-0.34	-0.001	-0.36
Future Consumption	0.696	2.11	0.468	0.81
Addictive Stock	0.034	0.71	0.060	0.73
Income	-0.000008	-0.95	-0.00002	-1.06
Fraction White			0.025	0.76
Percent Divorced			0.0004	0.16
Percent Unemployed			-0.0009	-0.44
Median Education			0.0001	0.05
Races	0.00005	5.84	0.00003	2.49
R Squared	.975		.777	
F	497.65		196.21	

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Table 8-20

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Handle Per Capita
Depreciation Rate = 10%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.215	-2.24	0.010	0.08
Future Price	0.060	0.51	0.134	0.77
Future Consumption	0.602	3.32	1.100	2.78
Addictive Stock	0.048	2.01	-0.026	-0.46
Income	-0.0009	-2.66	0.0003	0.31
Fraction White			-2.873	-1.47
Percent Divorced			0.219	1.47
Percent Unemployed			-0.275	-2.35
Median Education			0.187	1.47
Races	0.002	3.50	0.002	4.31
R Squared	.969		.786	
F	423.61		211.52	

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Table 8-21

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Handle Per Attendant
Depreciation Rate = 10%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.785	-1.86	-0.554	-1.75
Future Price	0.195	0.42	0.453	1.34
Future Consumption	0.349	1.09	0.610	3.10
Addictive Stock	0.084	2.23	0.042	2.02
Income	-0.0002	-0.26	-0.00004	-0.20
Fraction White			-1.366	-0.12
Percent Divorced			0.382	1.33
Percent Unemployed			-0.358	-1.54
Median Education			-0.450	-0.98
Races	-0.003	-1.54	0.001	0.65
R Squared	.936		.892	
F	187.97		461.61	

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Table 8-22

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Attendance Per Capita
Depreciation Rate = 20%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.002	-1.04	-0.0005	-0.27
Future Price	-0.001	-0.67	-0.0005	-0.19
Future Consumption	0.497	1.29	0.573	1.34
Addictive Stock	0.099	1.14	0.088	0.73
Income	-0.000007	-1.42	-0.000009	-2.10
Fraction White			0.015	0.82
Percent Divorced			-0.00002	-0.01
Percent Unemployed			-0.0005	-0.23
Median Education			0.0004	0.16
Races	0.00005	6.32	0.00001	1.33
R Squared	.977		.896	
F	537.31		483.97	

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Table 8-23

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Handle Per Capita
Depreciation Rate = 20%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.246	-2.42	-0.008	-0.07
Future Price	-0.061	-0.45	0.133	0.92
Future Consumption	0.243	0.89	1.102	3.75
Addictive Stock	0.144	2.54	-0.044	-0.63
Income	-0.0007	-2.45	0.00005	0.16
Fraction White			-2.883	-1.84
Percent Divorced			0.201	2.29
Percent Unemployed			-0.255	-3.88
Median Education			0.244	1.57
Races	0.002	3.24	0.002	3.90
R Squared	.965		.808	
F	373.31		242.62	

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Table 8-24

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Handle Per Attendant
Depreciation Rate = 20%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.737	-2.05	-0.520	-1.94
Future Price	0.160	0.40	0.435	1.54
Future Consumption	0.380	1.44	0.634	4.04
Addictive Stock	0.112	2.61	0.071	2.39
Income	-0.0002	-0.29	0.0002	0.14
Fraction White			-1.789	-0.20
Percent Divorced			0.227	1.23
Percent Unemployed			-0.279	-1.55
Median Education			-0.335	-0.95
Races	-0.002	-1.34	0.0006	0.50
R Squared	.953		.923	
F	261.29		674.91	

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Table 8-25

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Attendance Per Capita
Depreciation Rate = 30%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.003	-1.31	-0.0005	-0.26
Future Price	-0.003	-1.25	-0.0004	-0.17
Future Consumption	0.185	0.44	0.557	1.28
Addictive Stock	0.226	1.81	0.142	0.75
Income	-0.000006	-1.75	-0.000004	-0.71
Fraction White			0.007	0.69
Percent Divorced			-0.0001	-0.04
Percent Unemployed			-0.0002	-0.09
Median Education			0.0009	0.29
Races	0.00005	6.24	0.000008	0.45
R Squared	.974		.914	
F	474.13		593.35	

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Table 8-26

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Handle Per Capita
Depreciation Rate = 30%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.212	-2.26	-0.018	-0.16
Future Price	-0.130	-0.97	0.133	0.95
Future Consumption	0.160	0.60	1.091	4.05
Addictive Stock	0.218	2.95	-0.059	-0.65
Income	-0.0005	-1.99	-0.00003	-0.15
Fraction White			-2.666	-2.11
Percent Divorced			0.185	2.78
Percent Unemployed			-0.243	-4.62
Median Education			0.240	1.64
Races	0.002	3.44	0.002	3.82
R Squared	.970		.821	
F	438.84		264.46	

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Table 8-27

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Handle Per Attendant
Depreciation Rate = 30%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.703	-2.10	-0.496	-1.95
Future Price	0.179	0.49	0.436	1.65
Future Consumption	0.429	1.82	0.635	4.28
Addictive Stock	0.140	2.75	0.106	2.51
Income	-0.0002	-0.50	0.0002	0.14
Fraction White			-1.701	-0.20
Percent Divorced			0.165	1.07
Percent Unemployed			-0.228	-1.40
Median Education			-0.270	-0.85
Races	-0.001	-1.18	0.0004	0.34
R Squared	.960		.932	
F	305.43		772.13	

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Table 8-28

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Attendance Per Capita
Depreciation Rate = 40%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.002	-1.08	-0.0003	-0.20
Future Price	-0.003	-1.31	-0.0005	-0.25
Future Consumption	0.282	0.88	0.483	1.03
Addictive Stock	0.241	2.07	0.234	0.86
Income	-0.000004	-1.62	-0.0000003	-0.03
Fraction White			0.0007	0.07
Percent Divorced			-0.0004	-0.14
Percent Unemployed			0.0003	0.09
Median Education			0.002	0.45
Races	0.00005	6.84	0.000002	0.09
R Squared	.978		.912	
F	565.41		578.47	

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Table 8-29

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Handle Per Capita
Depreciation Rate = 40%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.172	-1.95	-0.023	-0.21
Future Price	-0.149	-1.18	0.130	0.94
Future Consumption	0.162	0.67	1.078	3.97
Addictive Stock	0.281	3.22	-0.071	-0.60
Income	-0.0004	-1.81	-0.00007	-0.39
Fraction White			-2.519	-2.22
Percent Divorced			0.177	2.99
Percent Unemployed			-0.239	-4.87
Median Education			0.227	1.68
Races	0.002	3.62	0.002	3.67
R Squared	.975		.830	
F	524.55		280.63	

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Table 8-30

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Handle Per Attendant
Depreciation Rate = 40%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.693	-2.12	-0.480	-1.91
Future Price	0.179	0.50	0.433	1.70
Future Consumption	0.429	1.86	0.613	4.03
Addictive Stock	0.178	2.78	0.150	2.56
Income	-0.0003	-0.55	0.0002	0.18
Fraction White			-1.971	-0.24
Percent Divorced			0.131	0.94
Percent Unemployed			-0.198	-1.27
Median Education			-0.238	-0.79
Races	-0.001	-1.09	0.0003	0.28
R Squared	.962		.936	
F	321.82		817.22	

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Table 8-31

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Attendance Per Capita
Depreciation Rate = 50%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.001	-0.81	-0.00001	-0.01
Future Price	-0.002	-1.24	-0.0005	-0.24
Future Consumption	0.361	1.29	0.493	1.24
Addictive Stock	0.251	2.12	0.283	0.99
Income	-0.000004	-1.44	0.0000007	0.08
Fraction White			-0.003	-0.26
Percent Divorced			-0.0001	-0.05
Percent Unemployed			0.0001	0.04
Median Education			0.001	0.49
Races	0.00005	6.99	0.000002	0.08
R Squared	.979		.914	
F	592.12		599.38	

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Table 8-32

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Handle Per Capita
Depreciation Rate = 50%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.143	-1.69	-0.023	-0.20
Future Price	-0.149	-1.25	0.123	0.89
Future Consumption	0.177	0.78	1.054	3.81
Addictive Stock	0.342	3.36	-0.075	-0.50
Income	-0.0004	-1.76	-0.00009	-0.55
Fraction White			-2.397	-2.29
Percent Divorced			0.171	3.11
Percent Unemployed			-0.236	-5.03
Median Education			0.213	1.70
Races	0.002	3.72	0.002	3.56
R Squared	.978		.840	
F	595.64		301.70	

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Table 8-33

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Handle Per Attendant
Depreciation Rate = 50%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.692	-2.12	-0.467	-1.86
Future Price	0.155	0.43	0.419	1.63
Future Consumption	0.398	1.67	0.575	3.52
Addictive Stock	0.230	2.76	0.204	2.57
Income	-0.0003	-0.54	0.0003	0.28
Fraction White			-2.706	-0.33
Percent Divorced			0.113	0.85
Percent Unemployed			-0.187	-1.22
Median Education			-0.220	-0.75
Races	-0.0009	1.03	0.0004	0.32
R Squared	.962		.937	
F	323.68		833.83	

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Table 8-34

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Attendance Per Capita
Depreciation Rate = 60%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.001	-0.60	0.0003	0.19
Future Price	-0.002	-1.17	-0.0003	-0.19
Future Consumption	0.401	1.55	0.531	1.68
Addictive Stock	0.271	2.14	0.302	1.13
Income	-0.000003	-1.33	0.0000001	0.02
Fraction White			-0.004	-0.36
Percent Divorced			0.0003	0.17
Percent Unemployed			-0.0003	-0.15
Median Education			0.001	0.46
Races	0.00005	6.96	0.000004	0.23
R Squared	.979		.918	
F	585.83		626.07	

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Table 8-35

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Handle Per Capita
Depreciation Rate = 60%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.124	-1.47	-0.018	-0.16
Future Price	-0.143	-1.25	0.110	0.82
Future Consumption	0.189	0.86	1.017	3.65
Addictive Stock	0.406	3.41	-0.066	-0.36
Income	-0.0004	-1.74	-0.0001	-0.68
Fraction White			-2.288	-2.35
Percent Divorced			0.165	3.22
Percent Unemployed			-0.233	-5.21
Median Education			0.201	1.72
Races	0.002	3.71	0.002	3.52
R Squared	.961		.936	
F	316.35		827.33	

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Table 8-36

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Handle Per Attendant
Depreciation Rate = 60%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.689	-2.09	-0.453	-1.78
Future Price	0.117	0.31	0.397	1.52
Future Consumption	0.353	1.40	0.531	2.95
Addictive Stock	0.293	2.71	0.266	2.54
Income	-0.0003	-0.53	0.0005	0.39
Fraction White			-3.659	-0.45
Percent Divorced			0.101	0.78
Percent Unemployed			-0.188	-1.22
Median Education			-0.202	-0.69
Races	-0.001	-0.97	0.0004	0.40
R Squared	.979		.851	
F	641.70		329.56	

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Table 8-37

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Attendance Per Capita
Depreciation Rate = 70%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.0007	-0.44	0.0005	0.32
Future Price	-0.002	-1.11	-0.0002	-0.15
Future Consumption	0.427	1.74	0.559	2.14
Addictive Stock	0.296	2.17	0.321	1.26
Income	-0.000003	-1.25	-0.0000004	-0.07
Fraction White			-0.004	-0.39
Percent Divorced			0.0006	0.43
Percent Unemployed			-0.0005	-0.38
Median Education			0.0009	0.40
Races	0.00005	6.87	0.000006	0.42
R Squared	.978		.918	
F	570.37		626.95	

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Table 8-38

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Handle Per Capita
Depreciation Rate = 70%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.109	-1.29	-0.010	-0.09
Future Price	-0.136	-1.22	0.095	0.74
Future Consumption	0.199	0.92	0.974	3.54
Addictive Stock	0.473	3.42	-0.043	-0.21
Income	-0.0003	-1.71	-0.0001	-0.78
Fraction White			-2.193	-2.42
Percent Divorced			0.160	3.34
Percent Unemployed			-0.230	-5.40
Median Education			0.190	1.74
Races	0.002	3.64	0.002	3.55
R Squared	.980		.863	
F	664.88		361.39	

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Table 8-39

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Handle Per Attendant
Depreciation Rate = 70%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.681	-2.01	-0.440	-1.67
Future Price	0.078	0.20	0.371	1.37
Future Consumption	0.310	1.13	0.490	2.44
Addictive Stock	0.366	2.61	0.333	2.46
Income	-0.0003	-0.53	0.0006	0.49
Fraction White			-4.590	-0.56
Percent Divorced			0.094	0.71
Percent Unemployed			-0.193	-1.23
Median Education			-0.177	-0.60
Races	-0.0008	-0.87	0.0006	0.49
R Squared	.959		.935	
F	302.80		801.53	

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Table 8-40

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Attendance Per Capita
Depreciation Rate = 80%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.0005	-0.31	0.0006	0.41
Future Price	-0.002	-1.05	-0.0002	-0.12
Future Consumption	0.450	1.93	0.578	2.57
Addictive Stock	0.320	2.20	0.340	1.38
Income	-0.00000	-1.19	-0.0000001	-0.17
Fraction White			-0.004	-0.40
Percent Divorced			0.0007	0.68
Percent Unemployed			-0.0008	-0.63
Median Education			0.0007	0.34
Races	0.00005	6.76	0.000007	0.63
R Squared	.977		.916	
F	551.82		614.13	

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Table 8-41

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Handle Per Capita
Depreciation Rate = 80%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.098	-1.14	-0.002	-0.02
Future Price	-0.129	-1.16	0.081	0.65
Future Consumption	0.208	0.97	0.931	3.47
Addictive Stock	0.539	3.39	-0.012	-0.05
Income	-0.0003	-1.65	-0.0001	-0.86
Fraction White			-2.119	-2.49
Percent Divorced			0.156	3.45
Percent Unemployed			-0.227	-5.59
Median Education			0.182	1.77
Races	0.002	3.54	0.001	3.63
R Squared	.980		.872	
F	669.99		392.52	

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Table 8-42

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Handle Per Attendant
Depreciation Rate = 80%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.670	-1.92	-0.430	-1.57
Future Price	0.050	0.12	0.347	1.23
Future Consumption	0.277	0.93	0.457	2.04
Addictive Stock	0.439	2.46	0.401	2.31
Income	-0.0003	-0.52	0.0007	0.56
Fraction White			-5.387	-0.64
Percent Divorced			0.086	0.64
Percent Unemployed			-0.199	-1.23
Median Education			-0.143	-0.48
Races	-0.0007	-0.73	0.0007	0.57
R Squared	.957		.931	
F	286.44		763.05	

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Table 8-43

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Attendance Per Capita
Depreciation Rate = 90%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.0003	-0.21	0.0007	0.46
Future Price	-0.002	-0.98	-0.0002	-0.10
Future Consumption	0.474	2.13	0.594	2.98
Addictive Stock	0.341	2.22	0.358	1.48
Income	-0.000003	-1.14	-0.000001	-0.27
Fraction White			-0.004	-0.40
Percent Divorced			0.0009	0.92
Percent Unemployed			-0.0009	-0.86
Median Education			0.0005	0.29
Races	0.00005	6.64	0.000008	0.84
R Squared	.977		.914	
F	531.89		595.55	

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Table 8-44

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Handle Per Capita
Depreciation Rate = 90%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.088	-1.00	0.006	0.06
Future Price	-0.122	-1.10	0.069	0.58
Future Consumption	0.219	1.02	0.895	3.43
Addictive Stock	0.605	3.34	0.022	0.09
Income	-0.0003	-1.58	-0.0001	-0.92
Fraction White			-2.066	-2.55
Percent Divorced			0.152	3.56
Percent Unemployed			-0.225	-5.76
Median Education			0.176	1.79
Races	0.002	3.42	0.001	3.74
R Squared	.980		.879	
F	661.04		419.02	

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Table 8-45

TSLS Estimates of Gambling Demand Equations
Dependent Variable = Handle Per Attendant
Depreciation Rate = 90%

Independent Variable	Track and Time Dummies	t	Demographic Variables	t
Price	-0.660	-1.83	-0.430	-1.50
Future Price	0.042	0.10	0.334	1.13
Future Consumption	0.266	0.83	0.441	1.77
Addictive Stock	0.504	2.27	0.460	2.12
Income	-0.0003	-0.51	0.0007	0.60
Fraction White			-6.030	-0.70
Percent Divorced			0.075	0.53
Percent Unemployed			-0.203	-1.22
Median Education			-0.099	-0.33
Races	-0.0005	-0.54	0.0008	0.64
R Squared	.955		.928	
F	271.76		722.13	

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depreciation rates get higher or lower. The coefficients for the addictive stock are all positive and are significant at all depreciation rates.

In the stock models for handle per capita the coefficients for current price are negative at all depreciation rates and they become more significant as the depreciation rate becomes lower. The coefficients on future price are negative at all depreciation rates except at ten percent, however, they are not significant. The coefficients on future consumption are positive but significant only at the depreciation rate of ten percent. The coefficients of the addictive stock are positive and significant at all rates of depreciation.

The stock models for attendance per capita do yield results consistent with the theory. The coefficients on current prices are negative at all depreciation rates, but are never significant. Future price is negative for all rates of depreciation. Future consumption and the addictive stock are positive and become more significant as the rate of depreciation increases. The coefficients of the addictive stock are positive and become more significant as the depreciation rate increases.

One of the basic tests for rational addictive behavior depends on the sign and significance of the estimated coefficients on future consumption. In all of the models estimated, a positive coefficient is obtained for future

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consumption. The statistical significance varies with the dependent variable and model specification. In the models with no assumed rate of depreciation on the addictive stock, the estimated coefficients are not significant for any of the dependent variables. In the models assuming a one hundred percent rate of depreciation on the addictive stock with no restrictions the estimated coefficients are significant at the one percent level for attendance per capita and handle per capita and at the five percent level for handle per attendant. In the models with the various restrictions (for handle per capita and handle per attendant only) ,the coefficients are significant at the one percent level for both dependent variables. Finally, for the various stock models, the significance of the estimated coefficients on future consumption varies with the dependent variable. The attendant per capita has more significant coefficients at higher rates of depreciation. The handle per capita is significant only when the depreciation rate is ten percent. The handle per attendant achieves the highest significance of six percent at the depreciation rate of forty percent with lower significance at higher or lower rates of depreciation. In all of the stock models, the addictive stock is positive and significant at all depreciation rates. These estimates imply that the reinforcement effect associated with gambling consumption plays a larger role in affecting current consumption than the shadow price of the addictive stock.

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The stock models were estimated assuming a variety of depreciation rates ranging from ten to ninety percent with the results presented above. Assuming a relatively high rate of depreciation appears to be more appropriate than assuming a relatively low rate of depreciation in the context of gambling. This is because withdrawal is not a major factor in the cessation of gambling and most of the negative effects of gambling disappear within a short time after gambling is stopped. However, because of gambling debts and the effects they may have on a gambler's credit rating may lead one to assume that the depreciation rate should not be assumed to be one hundred percent. For these reasons, among the stock models, the focus will be on relatively high rates of depreciation - either sixty or eighty percent. As the assumed rate of depreciation is reduced, the estimated coefficients on both current and future price rise somewhat in absolute value. At the same time the estimated coefficients on future consumption rise and then fall peaking at about the depreciation rate of forty percent for handle per attendant, they fall and then rise reaching a minimum at the depreciation rate of thirty percent for attendance per capita and handle per capita. The estimated coefficients of the addictive stock decrease and become slightly less statistically significant. Finally, the coefficients on the exogenous determinants of demand used in the specification with time dummies and demographic variables remain stable keeping the same sign as

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in the earlier results for all depreciation rates.

To this point, the results appear to support the assumption that gambling is, in fact, an addictive behavior. Whether gambling is a rational addictive behavior or whether gambling is an addictive behavior but individuals act myopically is not clear. The positive and mostly significant estimates obtained for the coefficients on future consumption for handle per attendant and attendance per capita support the former rational addictive behavior. However, the positive but mostly insignificant estimates for the coefficients on future consumption obtained for handle per capita gives weaker support. Still weaker support is found from the positive but insignificant estimates for the coefficients of future price in the addictive stock models for handle per capita and handle per attendant. The negative coefficients on future price for attendance per capita appear to support the alternative hypothesis gamblers act myopically. However, since betting is more appropriately the addictive behavior (not attending a track) rationality cannot be ruled out.

An examination of the estimates of the various price elasticities of demand and the roots of the difference equations presented in Chapter Six may help in deciding between the hypothesis of rational addictive behavior and myopic addictive behavior. These estimates are presented in the tables which follow. Table 8-46 contains the estimated own-price elasticities of demand for the models estimated

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under the assumption of non-addictive behavior. The discussion from this point will focus on the models for handle per capita and handle per attendant using the specification with time and track dummy variables. Table 8-47 contains estimates of the two roots of the second order difference equations represented by the gambling demand equations estimated with the rate of depreciation assumed to be one hundred percent with no restrictions; with no assumed rate of depreciation and no restrictions; with the rate of depreciation assumed to be one hundred percent with no restrictions in the first stage, consumption restricted in the second stage; with no assumed rate of depreciation with no restrictions in the first stage, price and consumption restricted in the second stage; and with no assumed rate of depreciation with price restricted in the first stage, prices and consumption restricted in the second stage. Table 8-48 contains estimates of the two roots of the second order difference equations represented by the gambling demand equations estimated with the rate of depreciation on the addictive stock assumed to be twenty, thirty, forty, fifty, sixty, seventy, eighty, and ninety percent. Table 8-49 contains price elasticities for the models with the depreciation rate equal to one hundred percent. Table 8-50 contains price elasticities for the models with the depreciation rate equal to one hundred percent and consumption restricted in the second stage. Table 8-51 contains price

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Table 8-46

Price Elasticities of Demand Non-Addictive Models		
Attendance Capita	Real Handle Per Capita	Real Handle Per Attendant
-1.247	-0.888	-0.454

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Table 8-47

Roots of Difference Equations

	Real Handle Per Capita		Real Handle Per Attendant	
	ϕ_1	ϕ_2	ϕ_1	ϕ_2
Unrestricted, rate of depreciation = 100%	.604	1.175	.340	1.938
Unrestricted, no rate depreciation assumed	.159	.972	.466	1.346
No restrictions in first stage, consumption restricted in second stage, rate of depreciation = 100%	.604	1.175	.341	1.937
No restrictions in first stage, price and consumption restricted in second stage, no assumed rate of depreciation	.698	1.017	.475	1.391
Price restricted in first stage, price and consumption restricted in second stage, no assumed rate of depreciation	.758	.937	.504	1.311

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Table 8-48

Roots of Difference Equations

	Real Handle Per Capita		Real Handle Per Attendant	
	ϕ_1	ϕ_2	ϕ_1	ϕ_2
Unrestricted, rate of depreciation = 20%	.312	1.075	.548	1.237
Unrestricted, rate of depreciation = 30%	.185	1.191	.593	1.550
Unrestricted, rate of depreciation = 40%	.186	1.237	.577	1.670
Unrestricted, rate of depreciation = 50%	.206	1.256	.525	1.649
Unrestricted, rate of depreciation = 60%	.222	1.255	.453	1.594
Unrestricted, rate of depreciation = 70%	.237	1.243	.389	1.523
Unrestricted, rate of depreciation = 80%	.250	1.234	.341	1.482
Unrestricted, rate of depreciation = 90%	.267	1.221	.325	1.460

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Table 8-49

Price Elasticities of Demand for Two Stage Models
Depreciation Rate = 100%

	Real Handle Per Capita	Real Handle Per Attendant
LONG RUN	-4.969	-0.678
CURRENT PRICE		
Temporary		
Anticipated	-0.604	-0.263
Unanticipated	-0.293	-0.217
Permanent		
Anticipated	-1.525	-0.398
Unanticipated	-0.741	-0.328
FUTURE PRICE		
Anticipated	-0.365	-0.089
Unanticipated	-0.177	-0.074
PAST PRICE		
Anticipated	-0.514	-0.135
Unanticipated	-0.250	-0.111

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Table 8-50

Price Elasticities of Demand for Two Stage Models
Depreciation Rate = 100%
No Restrictions in First Stage,
Consumption Restricted in Second Stage

	Real Handle Per Capita	Real Handle Per Attendant
LONG RUN	-4.969	-0.680
CURRENT PRICE		
Temporary		
Anticipated	-0.604	-0.263
Unanticipated	-0.293	-0.217
Permanent		
Anticipated	-1.525	-0.399
Unanticipated	-0.741	-0.329
FUTURE PRICE		
Anticipated	-0.365	-0.090
Unanticipated	-0.177	-0.074
PAST PRICE		
Anticipated	-0.514	-0.136
Unanticipated	-0.250	-0.112

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Table 8-51

Price Elasticities of Demand for Two Stage Models
No Assumed Rate of Depreciation
No Restrictions

	Real Handle Per Capita	Real Handle Per Attendant
LONG RUN	*	-0.557
CURRENT PRICE		
Temporary		
Anticipated	-0.459	-0.247
Unanticipated	-0.141	-0.186
Permanent		
Anticipated	-0.246	-0.475
Unanticipated	-0.448	-0.286
FUTURE PRICE		
Anticipated	-0.052	0.267
Unanticipated	-0.043	0.175
PAST PRICE		
Anticipated	-0.239	-0.040
Unanticipated	0.088	0.005

* not available, the sum of the coefficients on past and future consumption is greater than one.

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Table 8-52

Price Elasticities of Demand for Two Stage Models
No Assumed Rate of Depreciation
No Restrictions in First Stage,
Consumption and Prices Restricted in Second Stage

	Real Handle Per Capita	Real Handle Per Attendant
LONG RUN	-44.940	-0.549
CURRENT PRICE		
Temporary		
Anticipated	-0.799	-0.242
Unanticipated	-0.304	-0.212
Permanent		
Anticipated	-2.808	-0.482
Unanticipated	-0.827	-0.265
FUTURE PRICE		
Anticipated	-0.375	0.245
Unanticipated	-0.118	0.161
PAST PRICE		
Anticipated	-0.712	-0.064
Unanticipated	-0.225	-0.042

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Table 8-53

Price Elasticities of Demand for Two Stage Models
No Assumed Rate of Depreciation
Price Restricted in First Stage,
Consumption and Price Restricted in Second Stage

	Real Handle Per Capita	Real Handle Per Attendant
LONG RUN	*	-0.497
CURRENT PRICE		
Temporary		
Anticipated	-1.123	-0.229
Unanticipated	-0.319	-0.205
Permanent		
Anticipated	-5.327	-0.501
Unanticipated	-0.914	-0.245
FUTURE PRICE		
Anticipated	-0.642	0.269
Unanticipated	-0.123	0.166
PAST PRICE		
Anticipated	-1.129	-0.048
Unanticipated	-0.270	-0.030

* not available, the sum of the coefficients on past and future consumption is greater than one.

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elasticities for the models with no assumed rate of depreciation and no restrictions. Table 8-52 contains price elasticities for the models with no assumed rate of depreciation, and no restrictions in the first stage, consumption and price restricted in the second stage. Table 8-53 contains price elasticities for the models with no assumed rate of depreciation, price restricted in the first stage, and price and consumption restricted in the second stage. The price elasticity tables contain estimates of the long run price elasticity of demand, followed by short run price elasticities of demand for both temporary and permanent changes in price,and estimated response to temporary changes in future and past prices. The estimated short run price elasticities are presented for both anticipated and unanticipated changes in prices.

The estimated own-price elasticities of demand for models under the assumption of non addictive behavior are -1.247 for attendance per capita, -0.880 for handle per capita, and -0.454 for handle per attendant. These results are in the range of other authors for attendance per capita and handle per attendant but are substantially lower than those presented by other authors for handle per capita. For example, Morgan and Vasche (1979) report a price elasticity for attendance per capita to be -1.48. They update this estimate (1982) and report it to be -1.30. Gruen (1976) reports an elasticity of -1.57 while Pescatrice (1976) reports an elasticity of -1.07.

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Morgan and Vascne (1982) report that once present at a track, attendants follow fairly constant betting patterns, suggesting a relatively low elasticity, Suits, on the other hand reports (1979) relatively high elasticities for handle per capita ranging from -1.59 to -2.73. Gulley and Scott (1989a) on the other hand report price elasticities for handle per attendant to range from -0.39 to -0.46. Results obtained are in this range. Gulley and Scott do not include the takeout rates as a determining factor for attendance per capita. Before examining the estimated price elasticities obtained from the models of gambling demand as a rational addictive behavior, some discussing of the expected signs and magnitudes of the estimates is in order. As described in Chapter Six, if consumption is addictive, then both roots of the second order difference equations represented by the demand equations will be real and both will be positive. As Becker, Grossman, and Murphy note, the roots of the difference equations describe the dynamic response of current gambling to shocks to past and future gambling consumption (page 20). The smaller of the two roots, ϕ_1, gives the change in current consumption generated by shocks to future consumption, while the inverse of the larger root, ϕ_2, gives the effect of shocks to current consumption on future consumption. The shocks to past and/or future consumption can be the result of a change in any one of the factors which affect the demand for gambling, including a change in the past and/or future price of gambling.

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Becker, Grossman, and Murphy distinguish between several types of price changes. Temporary, one period, increases in price are expected to reduce consumption in all periods if the price change were expected. However, if the price change were unexpected, then consumption in periods prior to the change would not be affected, while consumption in all other periods would be affected. Similarly, permanent price increases are expected to lead reductions in consumption, beginning in the current period if the change is unanticipated, and in each period if the change were anticipated. The effect of a permanent increase in price in the current period on current consumption, the "short run" effect of Becker, Grossman, and Murphy, is expected to be smaller in absolute value than the effect of a permanent increase in price in all periods on current consumption, their "long run" price effect. Additionally, the effect on current consumption of an anticipated change in price beginning in the current period is expected to be larger in magnitude than the comparable effect of an equivalent unanticipated permanent change in price.

Finally, the effect on current consumption of a temporary change in current price is expected to be smaller in absolute value than the effect of a permanent change in price beginning in the current period.

The estimates obtained provide mixed support for the hypothesis that gambling is a rational addictive behavior, however a stronger support exists for the hypothesis that

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gambling is an addictive behavior. Many of the predictions of the model concerning the response of consumption to various changes in price are supported by the estimates while some of the other predictions are contradicted by the estimates of the demand equations.

For handle per capita and handle per attendant, both of the roots of the difference equations are positive and real, indicating that increases in either past or future consumption will lead to increases in current consumption. This implies that factors which lead to changes in past consumption, such as changes in past price, will not only affect past consumption but will also have an influence on current consumption.

The roots from the models estimated with no assumed rate of depreciation suggest that a ten percent rise in current consumption perhaps to a fall in the current price would result in approximately a 9.8 to 10.7 percent increase in next period's consumption for handle per capita. Similarly, a ten percent increase in next period's consumption, perhaps to a fall in future price, would result in approximately a 1.5 to 7.6 percent increase current consumption for handle per capita. A ten percent rise in current consumption would result in approximately a 7.2 to 7.6 percent increase in next period's consumption for handle per attendant. Similarly, a ten percent increase in next period's consumption would result in approximately a 4.7 to 5.0 percent increase in current

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consumption for handle per attendant.

The roots obtained when the depreciation rate on the addictive stock is assumed to be one hundred percent suggest a slightly smaller impact on future consumption of change in current consumption. For handle per capita, a ten percent rise in current consumption would result in an increase in future consumption of approximately 8.5 percent. A ten percent increase in next period's consumption would result in approximately a 6 percent increase in current consumption. For handle per attendant, a ten percent increase rise in next period's consumption would result in an increase in current consumption of approximately 5.2 percent. A ten percent increase in next period's consumption would result in approximately a 3.4 percent increase in current consumption.

Finally, using the roots from the stock models at the various rates of depreciation, a ten percent rise in current consumption would result in approximately a 8.0 to 9.3 percent increase in next period's consumption for handle per capita. Similarly, a ten percent rise in next period's consumption would result in approximately a 1.9 to 3.1 percent increase in current consumption for handle per capita. A ten percent increase in next period's consumption would result in approximately a 6.0 to 8.1 percent increase in current consumption for handle per attendant. Similarly, a ten percent increase in next period's consumption would result in approximately a 3.3 to 5.9 percent increase in current

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consumption for handle per attendant.

Turning now to an examination of the effects of price changes on consumption, the best support for the model of gambling as a rational addictive behavior is found for models assuming a depreciation rate of one hundred percent. The results are the same for both the unrestricted and restricted versions of the model.

For this handle per capita, a temporary increase in current, future or past price results in a fall in current consumption, with the fall larger for anticipated price increases than for unanticipated increases. A temporary increase of ten percent in the current price would lead to a decrease in current consumption of 6.0 percent of the price change were anticipated, and a decrease of 2.9 percent of the price change were unanticipated. Similarly, an ten percent anticipated increase in last period's gambling price would reduce consumption this period by 5.1 percent, with a decrease of 2.5 percent for the comparable unanticipated increase in price. Finally, a ten percent anticipated increase in next period's price would lead to a decrease in current consumption of 3.7 percent and a decrease of 1.8 percent of the price increase were unanticipated.

For this handle per attendant, a temporary increase in current, future or past price results in a fall in current consumption, with the fall larger for anticipated price increases than for unanticipated increases. A temporary

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increase of ten percent in the current price would lead to a decrease in current consumption of 2.6 percent of the price change were anticipated, and a decrease of 2.2 percent of the price change were unanticipated. Similarly, an ten percent anticipated increase in last period's gambling price would reduce consumption this period by 1.4 percent, with a decrease of 1.1 percent for the comparable unanticipated increase in price. Finally, a ten percent anticipated increase in next period's price would lead to a decrease in current consumption of 0.9 percent and a decrease of 0.7 percent of the price increase were unanticipated.

As expected, the magnitude of the effect on current consumption of a change in price is larger than that of a change in the price in the previous period. The effect on current consumption of change in last period's price is larger than the effect of a change in next period's price, as expected. In each case, the effect on consumption of an anticipated price change is greater than the effect of an unanticipated price change.

The response of current consumption to a permanent change in price is larger than the response to temporary changes in price, as predicted. For handle per capita, a permanent increase of ten percent in the price of gambling beginning in the current period would result in a decrease of 15.3 percent in current consumption if the increase were anticipated. If the ten percent increase in price were unexpected, then

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current consumption would fall by only 7.4 percent. For handle per attendant, a permanent increase of ten percent in the price of gambling beginning in the current period would result in a decrease of 4.0 percent in current consumption if the increase were anticipated. If the ten percent increase in price were unexpected, then current consumption would fall by only 3.3 percent. Finally, an increase of ten percent in gambling prices in every period would result in a decrease in current consumption of 49.7 percent for handle per capita and of 6.8 percent for handle per attendant.

For the models estimated assuming that the rate of depreciation on the addictive stock was one hundred percent, all of the predictions of the model of gambling as a rational addictive behavior are confirmed by the estimates. To summarize, current gambling consumption is inversely related to temporary changes in gambling prices in all periods. The response to permanent price changes is larger than the response to temporary price, with the longer run response larger than the short run response. Finally, if the price change were anticipated, then the resulting change in current consumption will be greater in magnitude than if the price change were unanticipated.

The results obtained from the estimation of the models assuming no rate of depreciation lends less support to the hypothesis that gambling is a rational addictive behavior. For handle per capita, the sum of the coefficients on past and

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future consumption is greater than one, so long run effects cannot be calculated. Also, current consumption is found to be positively related to temporary unanticipated changes in past gambling prices. A ten percent, temporary increase in the price of gambling in last period would result in an increase of between 0.9 and 2.7 percent. For handle per attendant, current consumption is found to be positively related to changes in future gambling prices. A ten percent, temporary increase in the price of gambling in the next period would lead to an increase in current consumption of between 2.5 to 2.7 percent if the change were anticipated and between 1.6 and 1.8 percent if the change were unanticipated.

Temporary increases in the current gambling price, however, does result in a decrease in current consumption. Based on the results of from this model, a temporary, anticipated increase of ten percent in the current price results in a decrease of between 1.1 and 8.0 percent for handle per capita and a decrease of between 2.3 and 2.5 percent for handle per attendant. If the increase in price were unanticipated, current consumption would decrease between 1.4 and 3.2 percent for handle per capita and between 1.9 and 2.2 percent for handle per attendant.

The response of current consumption to a permanent change in price is larger than the response to temporary changes in price. For handle per capita, a permanent increase of ten percent in the price of gambling beginning in the current

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period would result in a decrease of between 2.5 and 5.3 percent in current consumption if the increase were anticipated. If the ten percent increase in price were unexpected, then current consumption would fall by between 4.5 and 9.1 percent. For handle per attendant, a permanent increase of ten percent in the price of gambling beginning in the current period would result in a decrease of between 4.8 and 5.0 percent in current consumption if the increase were anticipated. If the ten percent increase in price were unexpected, then current consumption would fall by between 2.5 and 2.7 percent. Finally, an increase of ten percent in gambling prices in every period would result in a decrease in current consumption of between 5.0 and 5.6 percent for handle per attendant.

Tables 8-54 through 8-61 contain the estimates of price elasticities of demand for the models estimated assuming various rates of depreciation. As the assumed rate of depreciation increases, the elasticities tend to decrease in absolute value. When the various rates of depreciation are assumed, the qualitative results are essentially unchanged. Changes in the price of gambling in the current, past, or future period lead to lower current consumption for both handle per capita and handle per attendant. Anticipated changes have a greater effect than unanticipated changes. Permanent changes in prices have a greater effect than temporary changes. For handle per capita, a ten percent

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Table 8-54

Price Elasticities of Demand for Two Stage Models
Depreciation Rate = 20%

	Real Handle Per Capita	Real Handle Per Attendant
LONG RUN	-13.983	-2.493
CURRENT PRICE		
Temporary		
Anticipated	-0.931	-0.408
Unanticipated	-0.536	-0.276
Permanent		
Anticipated	-1.551	-0.772
Unanticipated	-0.974	-0.478
FUTURE PRICE		
Anticipated	-0.425	-0.164
Unanticipated	-0.301	-0.091
PAST PRICE		
Anticipated	-0.866	-0.330
Unanticipated	-0.498	-0.223

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Table 8-55

Price Elasticities of Demand for Two Stage Models
Depreciation Rate = 30%

	Real Handle Per Capita	Real Handle Per Attendant
LONG RUN	-5.086	-1.302
CURRENT PRICE		
Temporary		
Anticipated	-0.740	-0.341
Unanticipated	-0.413	-0.252
Permanent		
Anticipated	-1.218	-0.681
Unanticipated	-0.817	-0.462
FUTURE PRICE		
Anticipated	-0.390	-0.138
Unanticipated	-0.329	-0.085
PAST PRICE		
Anticipated	-0.621	-0.220
Unanticipated	-0.346	-0.163

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Table 8-56

Price Elasticities of Demand for Two Stage Models
Depreciation Rate = 40%

	Real Handle Per Capita	Real Handle Per Attendant
LONG RUN	-3.992	-1.057
CURRENT PRICE		
Temporary		
Anticipated	-0.668	-0.312
Unanticipated	-0.334	-0.242
Permanent		
Anticipated	-1.176	-0.591
Unanticipated	-0.765	-0.424
FUTURE PRICE		
Anticipated	-0.413	-0.118
Unanticipated	-0.351	-0.077
PAST PRICE		
Anticipated	-0.540	-0.187
Unanticipated	-0.270	-0.145

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Table 8-57

Price Elasticities of Demand for Two Stage Models
Depreciation Rate = 50%

	Real Handle Per Capita	Real Handle Per Attendant
LONG RUN	-3.540	-0.980
CURRENT PRICE		
Temporary		
Anticipated	-0.612	-0.300
Unanticipated	-0.281	-0.236
Permanent		
Anticipated	-1.141	-0.519
Unanticipated	-0.721	-0.386
FUTURE PRICE		
Anticipated	-0.418	-0.104
Unanticipated	-0.350	-0.071
PAST PRICE		
Anticipated	-0.489	-0.182
Unanticipated	-0.223	-0.143

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Table 8-58

Price Elasticities of Demand for Two Stage Models
Depreciation Rate = 60%

	Real Handle Per Capita	Real Handle Per Attendant
LONG RUN	-3.350	-0.934
CURRENT PRICE		
Temporary		
Anticipated	-0.574	-0.286
Unanticipated	-0.246	-0.229
Permanent		
Anticipated	-1.103	-0.453
Unanticipated	-0.681	-0.348
FUTURE PRICE		
Anticipated	-0.411	-0.091
Unanticipated	-0.338	-0.065
PAST PRICE		
Anticipated	-0.457	-0.180
Unanticipated	-0.196	-0.144

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Table 8-59

Price Elasticities of Demand for Two Stage Models
Depreciation Rate = 70%

	Real Handle Per Capita	Real Handle Per Attendant
LONG RUN	-3.296	-0.935
CURRENT PRICE		
Temporary		
Anticipated	-0.541	-0.275
Unanticipated	-0.219	-0.222
Permanent		
Anticipated	-1.067	-0.409
Unanticipated	-0.644	-0.321
FUTURE PRICE		
Anticipated	-0.238	-0.315
Unanticipated	-0.401	-0.082
PAST PRICE		
Anticipated	-0.436	-0.181
Unanticipated	-0.176	-0.145

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Table 8-60

Price Elasticities of Demand for Two Stage Models
Depreciation Rate = 80%

	Real Handle Per Capita	Real Handle Per Attendant
LONG RUN	-3.235	-0.922
CURRENT PRICE		
Temporary		
Anticipated	-0.515	-0.263
Unanticipated	-0.197	-0.214
Permanent		
Anticipated	-1.035	-0.375
Unanticipated	-0.614	-0.300
FUTURE PRICE		
Anticipated	-0.390	-0.074
Unanticipated	-0.311	-0.057
PAST PRICE		
Anticipated	-0.417	-0.178
Unanticipated	-0.161	-0.144

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Table 8-61

Price Elasticities of Demand for Two Stage Models
Depreciation Rate = 90%

	Real Handle Per Capita	Real Handle Per Attendant
LONG RUN	-3.253	-0.921
CURRENT PRICE		
Temporary		
Anticipated	-0.494	-0.257
Unanticipated	-0.181	-0.209
Permanent		
Anticipated	-1.016	-0.362
Unanticipated	-0.588	-0.290
FUTURE PRICE		
Anticipated	-0.382	-0.070
Unanticipated	-0.299	-0.055
PAST PRICE		
Anticipated	-0.405	-0.176
Unanticipated	-0.148	-0.143

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temporary anticipated increase in price in the beginning of the current period will reduce current consumption in these models by approximately 4.9 to 9.3 percent. If the price increase were unanticipated, the estimated decrease in consumption would be approximately 1.8 to 5.4 percent. A ten percent permanent anticipated increase in current price would reduce current consumption approximately 10.4 to 15.5 percent. If the price increase were unanticipated the estimated decrease in consumption would be approximately 5.9 to 9.7 percent.

A ten percent anticipated increase in last period's gambling price would reduce consumption this period approximately 6.0 to 10.0 percent, with a decrease of approximately 4.7 to 7.1 percent if the increase were anticipated. A ten percent anticipated increase in next period's price would lead to a decrease of approximately 4.1 to 8.7 percent in current consumption and a decrease of approximately 1.5 to 5.0 percent if the price increase were unanticipated. Finally, the long run effect of a ten percent increase in gambling prices in every period is approximately 32.5 to 139.8 percent.

For handle per attendant, a ten percent temporary anticipated increase in price in the beginning of the current period will reduce current consumption in these models by approximately 2.6 to 4.1 percent. If the price increase were unanticipated, the estimated decrease in consumption would be

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approximately 2.1 to 2.8 percent. A ten percent permanent anticipated increase in current price would reduce current consumption approximately 3.6 to 7.7 percent. If the price increase were unanticipated the estimated decrease in consumption would be approximately 2.9 to 4.8 percent.

A ten percent anticipated increase in last period's gambling price would reduce consumption this period approximately 3.8 to 5.1 percent, with a decrease of approximately 2.8 to 3.4 percent if the increase were anticipated. A ten percent anticipated increase in next period's price would lead to a decrease of approximately 1.8 to 3.3 percent in current consumption and a decrease of approximately 1.4 to 2.2 percent if the price increase were unanticipated. Finally, the long run effect of a ten percent increase in gambling prices in every period is approximately 9.2 to 24.9 percent.

Conclusions

The results from the estimation of the various demand equations developed in Chapter Six, along with the estimated price elasticities of demand for each of these equations were presented in this chapter. In addition to these equations, a set of demand equations was estimated under the assumption that gambling is a non-addictive behavior. The three dependent variables were attendance per capita, handle per capita and handle per attendant.

Support for the hypothesis that gambling consumption

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exhibits adjacent complementarity is found for all three dependent variables. This is the main test for whether or not consumption is addictive.

Handle per attendant gave the best results in the context of rational addiction. The results obtained from the estimation provide relatively strong support for the hypothesis that gambling is addictive behavior and somewhat less support for the hypothesis that this behavior is rational. The signs and relative magnitudes of the estimated coefficients on gambling prices and past and future gambling consumption are consistent with he predictions of the model of gambling as a rational addictive behavior for both handle per capita and handle per attendant. The predictions concerning the various price elasticities support the model when the depreciation rate is assumed to be one hundred percent and when depreciation rates are assumed to be less than one hundred percent; are somewhat less supportive when there is no assumed rate of depreciation.

The positive and significant coefficients on past consumption and the real, positive roots obtained from the second order difference equations suggest anything which affects past or future gambling consumption will affect current consumption in the same direction. Ignoring the intertemporal linkages for gambling consumption, (i.e. ignoring the addictive nature of the consumption) leads to estimated long run price elasticities of demand one-fifth to

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four-fifths the estimated long run price elasticities obtained when accounting for the addictive aspects of consumption. Thus, ignoring addiction would lead one to conclude that the use of the take out rate is an ineffective means of changing gambling consumption. Long run price elasticities of demand of -0.50 to -2.49 are obtained from the estimation of the demand equations for handle per attendant developed in the rational addiction framework. Thus reducing the takeout rate from 20 to 18 percent would increase handle per attendant by approximately 5 to 25 percent depending upon what rate of depreciation is assumed for the addictive stock.

The estimates obtained for the demand equations derived assuming the rate of depreciation on the addictive stock is one hundred percent are consistent in every way with the model of rational addictive behavior. Current gambling consumption is inversely related to the price of gambling in every period, permanent price changes affect consumption more than temporary price changes, anticipated price changes have a larger impact than the comparable unanticipated price changes, and long run price elasticities of demand exceed short run price elasticities of demand. These estimates are potentially more reliable than the estimates obtained from the equations when no assumption is made on the rate of depreciation because they are less taxing on the data.

The estimates from the stock equations provide strong support for the assumption that gambling is an addictive

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behavior, but proved only mixed support for the rationality assumption. The coefficients on future price and consumption are positive but not significant. However, using the coefficients to determine price elasticity yields support to rational addiction. Temporary increases in past, current or future prices lead to reductions in current gambling consumption. Permanent price changes have a greater effect than temporary changes and anticipated changes have a larger impact than unanticipated changes. The long run price elasticities exceed the short run price elasticities of demand.

The estimates obtained from the most general model, that which makes no assumption concerning the rate of depreciation on the addictive stock and, hence, includes lagged, current and led prices in addition to instruments for lagged and led gambling consumption, are mostly inconsistent with the model of gambling as a rational addictive behavior. These estimates, however, can be considered the least reliable because they are the most taxing on the data, but do provide at least some support for the model when an F test allowed the rejection that future consumption and future price are jointly equal to zero. All estimated coefficients in these models are consistent with the predictions of the model.

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Chapter Nine

Summary

This dissertation applied the model of rational addiction developed by Gary Becker and Kevin Murphy to gambling. After a brief introduction, a discussion of the availability of gambling in the United States was presented in Chapter Two. The major goal of this chapter was to illustrate the fact that the availability of legal forms of gambling to the American public has increased dramatically since 1950. State lotteries provided the major increases in availability, however, increases in pari-mutuel availability, both horseracing and greyhound racing, were substantial. Chapter Two also included a description of how pari-mutuel betting operates, since this dissertation presents results only for this type of gambling.

Chapter Three reviewed the extensive body of non-economic literature on gambling. To provide some support for many of the assumptions made in the exposition of the theoretical model of gambling as a rational addictive behavior, the physiological and psychological mechanisms involved in gambling were reviewed. In particular, a discussion of the factors that lead the psychiatric community to view gambling as an addictive behavior only since the early 1980's was presented. A discussion of the mechanisms through which gambling produces increments to utility was presented, with the basic conclusion that gambling is an effective way to modify an individual's psychological state. An addictive

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behavior is defined by the presence of acquired tolerance, reinforcement factors in consumption, and withdrawal symptoms associated with the cessation of consumption. Each of these factors was discussed in the context of gambling.

Chapter Four reviewed the recent economics literature on gambling, emphasizing the findings of others concerning the price elasticity of gambling demand.

Chapter Five presented the Becker-Murphy theoretical model of rational addictive behavior applied to gambling recalling the discussion of Chapter Three to justify the various assumptions.

Chapter Six used the theoretical model presented in Chapter Five to construct alternative gambling demand equations which explicitly accounted for the addictive aspects of gambling consumption. In addition, gambling demand equations were derived under the competing hypothesis that gambling is an non-addictive behavior and that gambling is an addictive behavior, but that individuals behave myopically. These various demand equations were compared in order to discuss the manner which the hypothesis that gambling is a rational addictive behavior could be tested. This was followed by the derivation of a variety of price elasticities of demand, together with a discussion concerning the expected relative magnitudes of these elasticities.

Chapter Seven contained a description of the primary data set employed in the estimation of the gambling demand

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equations.

Chapter Eight contained the results from the basic models for three dependent variables. In addition to the results from the estimation of demand equations derived under the assumption of non-addictive behavior, the results of the addictive demand equations were presented. Finally, the results from the addictive models which included the stock of past gambling consumption were presented for alternative assumed rates of depreciation, ranging from ten to ninety percent, on the addictive stock.

The results can be summarized as follows:

1. In general, the estimated coefficients on gambling prices, future gambling consumption and past gambling consumption or the stock of past consumption, are consistent with the predictions of the model of rational addictive behavior. That is, average gambling consumption is inversely related to the current price of gambling, holding past and future gambling consumption constant. Current gambling consumption is positively related to the lagged and future gambling prices, when included, holding past and future consumption constant. Similarly, current gambling consumption is positively related to the past and future gambling consumption, holding current gambling price, and in some cases, past and future gambling prices constant. In each case, the effect of past consumption or past price is larger in magnitude than the effect of future consumption or future

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price. Finally, the estimated coefficients on the stock of past consumption are positive, suggesting that reinforcement factors associated with past consumption, represented by the stock, outweigh the increase in the full price of gambling associated with an increase in the stock.

2. Models estimated assuming relatively high rates of depreciation on the stock of past consumption were, generally, more consistent with expectations and could be justified on a theoretical basis.

3. The results form all of the models estimated support the contention that gambling is an addictive behavior. In every model, strong intertemporal linkages between consumption were found, evidence that gambling consumption exhibits adjacent complementarity, the Becker-Murphy criterion for addictive behavior in an economic sense. That is, factors which affect consumption in any single period will have similar effects on consumption in all other periods. Ignoring these linkages (i.e. assuming that gambling is non-addictive) leads to a substantial underestimate of the long run response to changes in gambling prices.

4. Somewhat weaker support is found for the assumption for the assumption that gambling is a rational addictive behavior. In general, the various estimated price elasticities of demand provide mixed support for the hypothesis that individuals behave rationally. However, the importance of future effects, particularly future consumption, implies that individuals are

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not behaving myopically. In general, the estimates from the models least taxing on the data provide the strongest support for the Becker-Murphy model of rational addiction.

5. Estimated long run price elasticities of demand based on the results from the demand equations derived under the assumption of rational addictive behavior, for handle per attendant range from -0.50 to -2.49. These estimates suggested a substantially larger response to changes in price than did the estimates obtained from comparable equations estimated under the assumption of non-addictive behavior, implying that ignoring the addictive aspects of consumption could lead to erroneous conclusions concerning the effectiveness of takeout rates on changing gambling consumption.

6. The results using demographic variables were somewhat disappointing. The results were consistent with regard to direction, but for the most part were insignificant for the most general models. The fraction of the population that is white and the unemployment rate had a negative effect on consumption, while the divorce rate and education had a positive effect on consumption. In the stock models, the demographic variables gave results similar to the other models, however, the future price and future consumption effects tended to be positive and more significant than the specifications using track and time dummies.

The major conclusion of this dissertation, i.e. the

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substantial effects of the takeout rate on consumption could be considered by state legislatures when determining and legislating the takeout rate. The decision to change the takeout rate would then depend on the goal of the state -- to reduce gambling consumption because of its effects on society, or to increase gambling because of its positive effects in generating revenue to the state.

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