J Gambl Stud
DOI 10.1007/s10899-014-9453-6

ORIGINAL PAPER

Setting Win Limits: An Alternative Approach to "Responsible Gambling"?

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Abstract Social scientists, governments, and the casino industry have all emphasized the need for casino patrons to "gamble responsibly." Strategies for responsible gambling include self-imposed time limits and loss limits on gambling. Such strategies help prevent people from losing more than they can afford and may help prevent excessive gambling behavior. Yet, loss limits also make it more likely that casino patrons leave when they are losing. Oddly, the literature makes no mention of "win limits" as a potential approach to responsible gambling. A win limit would be similar to a loss limit, except the gambler would leave the casino upon reaching a pre-set level of winnings. We anticipate that a self-imposed win limit will reduce the gambler's average loss and, by default, also reduce the casino's profit. We test the effect of a self-imposed win limit by running slot machine simulations in which the treatment group of players has self-imposed and self-enforced win and loss limits, while the control group has a self-imposed loss limit or no limit. We find that the results conform to our expectations: the win limit results in improved player performance and reduced casino profits. Additional research is needed, however, to determine whether win limits could be a useful component of a responsible gambling strategy.

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Published online: 25 February 2014

Keywords Responsible gambling · Loss limits · Win limits · Mental accounting

Introduction

As casinos have become increasingly widespread over the past two decades, the importance of "responsible gambling" practices or strategies that gamblers can take to minimize the potential harms associated with gambling and protect against the development of gambling disorders has been increasingly emphasized in the social science literature.[1] Clinicians, researchers and the casino industry alike have contributed to the development of guidelines for "gambling responsibly", with the focus of these guidelines on promoting consumers' informed decision making and accountability for their own wagering behavior (Wood et al. 2014). Pre-commitment strategies in particular, such as setting and adhering to monetary loss or time limits on gambling, have gained significant impetus as an important responsible gambling initiative (Ladouceur et al. 2012). Interestingly, we can find no mention in the literature of "win limits" as a component of responsible gambling.

In this paper, we examine the impact of self-imposed win limits for casino gambling. We discuss the statistical nature of casino games and run a slot machine simulation to explore whether a self-imposed win limit could be an important component of a responsible gambling strategy. We find that players setting win limits would, *ceteris paribus*, lose less money on average playing casino games than players who set only loss limits. This paper provides a foundation for clinicians and researchers who may wish to study how the use of win limits could help in promoting responsible gambling. It also suggests another potentially effective component for the casino industry's "responsible gaming" campaign, although win limits and loss limits act to reduce casinos' gross revenues. The paper is organized into five sections. In the Background on "responsible gambling" section we provide a discussion focusing on gambling research and corporate responsibility. The Effects of loss limits and win limits section discusses loss limits, time limits, and win limits in general terms. In the Casino simulation section we develop a slot simulation to determine the expected impact of win limits on the average casino customer's gambling session. The Discussion section discusses various facets of the simulation results, and the Conclusion section summarizes and concludes the paper.

Background on "Responsible Gambling"

With the development of gambling research over the past two decades, there has been increased effort to minimize the prevalence and harms associated with excessive gambling, and in raising awareness about how to gamble responsibly. "Responsible gambling" refers to policies and practices designed to restrict an individual's gambling expenditure in terms of money and time spent gambling within affordable limits (Blaszczynski et al. 2013). The concept is akin to limits recommended for low-risk alcohol consumption (Currie et al. 2008, p. 207).

[1] The terminology used to describe gambling problems has changed over time. The current term is "disordered gambling" (Petry et al. 2013). A detailed description of the disorder and how different terms relate to severity is beyond the scope of this paper.

Research on gambling disorders and harm minimization is warranted not only by the enormous growth in the casino industry, but also because there is evidence that a significant proportion of gambling is done by disordered gamblers (Orford et al. 2013). One study found that among online casino gamblers, about 3 % of customers provided about 50 % of the casino's revenues, and about 11 % provided 80 % of casino revenues (Maremont and Berzon 2013). In this section we examine the efforts by the casino industry, government, and researchers to develop and promote responsible gambling. Such efforts can be seen as a catalyst for many regulations implemented by states to address concerns related to gambling problems.

Corporate Social Responsibility

The importance of corporate social responsibility has not escaped the gaming industry.[2] Gaming companies are often highly philanthropic, support green initiatives, and actively promote their support of responsible gambling initiatives. As noted by the [British] Responsible Gambling Trust (2013), the continued funding of research, education and treatment initiatives by gaming corporations ultimately enhances the industry's reputation for responsible gambling promotion and illustrates that gambling expansion is balanced with social protection of vulnerable populations.

The most visible and consistently publicized aspect of gaming companies' voluntary code of ethics relates to the issue of responsible gambling. While Blaszczynski et al. (2004) note that "there is no clear operational definition or consensus as to what '*responsible gaming practices*' or '*responsible code of conduct*' actually means" (p. 306), these authors do offer their own definition:

> Responsible gambling refers to policies and practices designed to prevent and reduce potential harms associated with gambling; these policies and practices often incorporate a diverse range of interventions designed to promote consumer protection, community/consumer awareness and education, and access to efficacious treatment (p. 308).

Since 1996, the American Gaming Association (AGA)[3] has funded its responsible gambling campaign through contributions from its member casinos. For example, the AGA funds the National Center for Responsible Gaming (NCRG), "the only national organization exclusively devoted to funding research that helps increase understanding of pathological and youth gambling and find effective methods of treatment for the disorder. The NCRG is the AGA's affiliated charity."[4] In 1997, the AGA began its Responsible Gaming National Education Campaign. The AGA's brochure, "Keeping it Fun: A Guide to Responsible Gaming" (2003)[5] lists four key characteristics of responsible gambling:

1. Responsible gamers understand that gambling by its nature entails risk and that the odds of winning are with the house.
2. Responsible gaming is done socially, with family, friends or colleagues.

[2] The casino industry prefers to use the term "gaming." We tend to use the terms gambling and gaming interchangeably.

[3] The AGA is the US commercial casino industry's lobbying organization. It spends a significant amount of money lobbying politicians (Walker and Calcagno 2013).

[4] http://www.ncrg.org/about-ncrg.

[5] http://www.americangaming.org/social-responsibility/responsible-gaming/keep-it-fun.

3. Responsible gaming is done for limited amounts of time, both in frequency and duration.
4. Responsible gaming always has predetermined acceptable limits for losses.

Similar information is also available in many casinos. Typically, a player can find brochures at the casino's entrance, at the cashier's cage, or on the casino floor that list tips for how to gamble responsibly. Our anecdotal evidence suggests that such brochures are available at many US casinos, but the casino patron may have to seek them out. For example, the new Hollywood Casino in Columbus, OH, offers a brochure titled "Responsible Gaming Program" openly on the casino floor. The brochure lists warning signs of problem gambling, as well as responsible gambling tips. These include:

- Set a budget and stick to it.
- Set a time limit and stick to it.

Presumably then, the goal of any responsible gambling code of conduct is to ensure that consumers gamble within the confines of their discretionary disposable income and leisure time, and to ensure that gambling remains just a form of entertainment. Indeed, as highlighted above, the focus of most industry responsible gambling promotional material is on limiting the amount of time spent gambling and the amount of money a person loses, and adhering to those limits. This is important because psychologists often define a gambling disorder relative to a player's losses and inability to limit or stop gambling.

Government Regulations

In response to community concerns and pressures regarding the legalization and expansion of gaming in several jurisdictions, governments and the industry have introduced regulatory policies aimed at reducing the incidence and prevalence of disordered gambling (Blaszczynski et al. 2013). Public health or regulatory policies implemented by governments and industry to prevent the adoption of risky gambling practices often focus on environmental controls on the availability of gambling (Williams et al. 2007). Existing policies include minimum-age regulations aimed at restricting underage access to legal gaming opportunities (Derevensky et al. 2004), jurisdictional caps on the number of new gambling facilities or the number of electronic gambling machines (EGMs) outside of dedicated areas (Adams et al. 2009), and limits on service hours of EGMs and gambling venue hours of operation (Cantinotti and Ladouceur 2008). Given evidence suggesting that legal gambling availability is positively associated with disordered gambling (see St-Pierre et al. in press, for a review of the empirical literature), policies that focus on restricting the availability of gambling opportunities are proposed to be a necessary component in the prevention of gambling problems.

The recognized merit of this approach in preventing gambling problems notwithstanding, information regarding the effectiveness of availability restrictions is limited. In a natural experiment in the Canadian province of Nova Scotia, a 30 % reduction in the number of video lottery terminals (VLTs) available in licensed premises, combined with reduction in their service hours, was found to result in an overall 11 % decrease in VLT play time, with the largest reductions in VLT play time observed among gamblers with higher risk profiles (i.e., moderate risk and problem gamblers) (Corporate Research Associates 2006). Additionally, Lund (2009) conducted a prospective study examining changes in levels of problem gambling following the ban of all EGMs except automatic bingo machines in Norway beginning in July 2007. Results demonstrated significant

Table 1 Summary of states' responsible gambling efforts

OVERVIEW OF STATUTES AND REGULATIONS*

	CO	DE	FL	IL	IN	IA	LA	ME	MI	MS	MO	NV	NJ	NM	NY	OK	PA	RI	SD	WV
800 Help Line			■	■	■	■	■		■			■	■				■			■
Advertising Restrictions							■	■					■		■					
Alcohol Service	■					■	■	■			■									
Credit Restrictions	■						■	■			■		■			■	■			
Employee Training			■	■		■	■	■		■		■		■	■	■	■			
Employee P.G. Prevention			■				■	■								■	■			
Loss Limit/Limited Stakes	■										■								■	
Marketing/Direct Mail							■	■			■									
Posters/Signage			■	■	■	■	■	■		■		■	■		■	■	■			■
Public Awareness			■	■			■		■							■	■			
Self-exclusion**			■	■	■		■	■	■	■	■	■	■		■		■			
Treatment Funding	■	■			■	■	■	■	■		■	■	■	■	■	■	■		■	

** *Placement on a self-exclusion list may result in exclusion from credit access, complimentaries, check cashing, players club benefits and direct mail marketing.*

■ = *Statutory/regulatory language and implemented*
**As of December 2007*

Source: American Gaming Association (2008)

reductions in problem gambling prevalence following the removal of EGMs from the market, with the rates in the overall sample falling from 1.0 to 0.4 %. Conversely, from their analysis of data from the *Canadian Gambling Digest*, Williams et al. (2007) reported a statistically non-significant correlation between jurisdictional problem gambling prevalence rates and the number of EGMs outside of gambling venues per capita. From this body of research, it appears that current policies aimed at restricting the availability of legal gambling opportunities show moderate success in reducing or preventing gambling participation, but that further harm-minimization measures need to be imposed to prevent the development of gambling problems.

Table 1 is reproduced from an AGA publication. It lists each U.S. state's statutes and regulations that are related to responsible gaming. The types of regulations listed give a general overview of how states have attempted to address disordered gambling and promote responsible gambling.

Gambling Research

There has been some economic research that focuses on gambling behavior, most of which can trace its roots back to the classic paper by Friedman and Savage (1948). Of particular interest for this paper is the literature on "mental accounting." For example, Thaler and Johnson (1990) examine how people's betting behavior exhibits increased risk-taking

when they are playing with "house money." Economics research has also suggested that a loss has a greater impact on a person than a win of equal magnitude.[6]

The psychology literature, in contrast, is much more developed with respect to understanding gambling behavior among casino patrons and at-risk individuals who may be most interested in responsible gambling strategies. Research on disordered gambling has focused on ways to minimize the harms related with excessive play behavior (see, for example, Korn and Shaffer 1999). Although many gambling disorders are observed to stem from casino and EGM betting, research has also addressed harm reduction for Internet gambling (Broda et al. 2008). Researchers have not adopted an upper limit on gambling that defines responsible gambling, although Currie et al. (2008) suggest it might be "any level of gambling that does not contribute to harm" (p. 208).

Efforts to reduce gambling-related harms often concentrate on preventing excessive gambling expenditure. Pre-commitment is a harm-minimization measure designed to prevent excessive gambling expenditure, and involves setting personal monetary and/or time limits prior to engaging in gambling behavior (Ladouceur et al. 2012). From the small base of empirical literature examining limit setting for gambling expenditure, it appears that at least half of all gamblers voluntarily set monetary loss limits for themselves, while one-third or less set time limits (Blaszczynski et al. 2013; Griffiths et al. 2009; Ladouceur et al. 2012; Moore et al. 2012). Preliminary research findings also suggest that player-initiated limits on gambling expenditure are preferred over company-defined limits as a responsible gambling strategy (Auer and Griffiths 2013; Wood et al. 2014). This is because self-imposed limits do not overly interfere with non-problematic play and their use encourages rational decision making, which has been shown to be an effective harm-minimization strategy.

Evidence for the effectiveness of setting monetary or time expenditure limits, however, is limited and mixed. In a study of 5,000 online gamblers, Auer and Griffiths (2013) observed that voluntary monetary limit setting among the most intense casino gamblers demonstrated significant decreases in the amount of money lost as a direct result of limit setting. On the other hand, they also found that setting voluntary time limits had no significant effect on decreasing monetary losses among the most intense casino gamblers. In another study of 47,134 online gamblers, Nelson et al. (2008) observed that gamblers who self-imposed limits on their gambling expenditures significantly reduced their betting frequency, both in terms of the number of days that they placed wagers and the number of wagers they placed per betting day. In addition to reductions in betting frequency, the authors noted significant reductions in the total amount of money wagered among self-limiting gamblers. However, Nelson et al. did not report any significant changes in the amount wagered per bet or net loss after imposing self-limits on gambling expenditures.[7]

With regards to EGM gambling, there has also been mixed evidence setting monetary or time expenditure limits. For example, in their study of 65 regular EGM players, Lalande and Ladouceur (2011) reported that non-problem gamblers who set a loss limit spent a comparable amount of money in a gambling session as those who did not set a limit, whereas problem gamblers that did not set monetary limits spent more money in a gambling session than those who had set a limit. However, the authors also found that 42 % of the problem gamblers in their sample spent more than their loss limit in a gambling session, compared to only 8 % of the non-problem gamblers. Additionally, drawing from a convenience sample of 38 EGM players, Ladouceur and Sévigny (2009) reported that

[6] Research in this area is called "prospect theory," and goes back to Kahneman and Tversky (1979).

[7] One potential problem with studies of online gamblers is that it cannot be known whether gamblers simply move to other websites to continue gambling.

79 % of their respondents indicated that setting time limits on gambling was not useful in controlling their gambling activities, and that 82 % said that this pre-commitment strategy generally did not make them stop playing once the time limit expired.

One plausible explanation for the non-adherence to monetary loss limits in EGM gambling is the availability of jackpots. A recent study revealed that the availability of large linked jackpots (i.e., jackpots that can be won on several EGMs, and the trigger of a jackpot win on one EGM precludes the win on another) is one factor reported by players to influence non-adherence to pre-commitment limits (Schottler Consutling 2010). Of interest, however, Wohl et al. (2013) observed that reminder messages regarding self-imposed monetary limits may facilitate adherence to those preset limits among EGM players. Specifically, they found that participants who were provided with a pop-up message informing them that their monetary limit had been reached during EGM gambling adhered to their preset limits significantly more (97 %) than participants who did not receive a reminder message (77 %).

Although the impact of pre-commitment strategies on wagering behavior has been increasingly explored in the online and EGM gambling research literature, the effectiveness of time and monetary limit-setting for different game offerings has not yet been investigated. Intuitively, self-imposed expenditure limits could be considered less efficacious for certain land-based games (e.g., casino card and table games) given that the structural characteristics of these games do not allow for the provision of integrated limit-setting tools or game-related feedback (Wood et al. 2014). Consequently, the salience of self-imposed pre-commitment expenditure limits for these game types may weaken as play behavior persists over time.

In addition to player-defined betting limits, there is also some emerging research investigating the effectiveness of responsible gambling "bank" features, which prevent winnings from being re-gambled by depositing them into a quarantined credit meter that can be collected only upon termination of a gambling session (Blaszczynski et al. 2013). To date, however, win limits as discussed in this paper have not been suggested or tested as a component of a comprehensive responsible gambling or pre-commitment strategy. The only references to the importance and usefulness of "win limits" that we were able to locate originate from books on "how to beat the casino." For example, in *The Everything Casino Gambling Book: Feel Confident, Have Fun, and Win Big!*, Schneider (2004, pp. 214–215) writes:

> Setting limits on your winnings is just as important as setting limits on your losses, and for the same reason. Many a player has found himself up a huge amount at the table or slot machine, only to go home empty-handed because he continued to play well past the point where he should have quit. Remember, the longer you play any game at the casino, the more the odds swing in the casino's favor.

Interestingly, this advice, heretofore unexplored in the gambling literature, touches on several critical components of the analysis that makes up this study. In the remainder of the paper, we examine how loss limits and win limits affect the average casino gambler's results and the casino's bottom line.

Effects of Loss Limits and Win Limits

Industry, government, and researchers agree that responsible gambling strategies can help to prevent excessive gambling behavior and related problems. The literature contains extensive work related to such strategies and their effectiveness (e.g., Blaszczynski et al.

2004). One issue raised herein is whether these guidelines, designed to help avoid duress on the part of the gambler, hurt or in fact help the casino. One would assume that advising gamblers to play responsibly and limit their losses to that which they can comfortably afford would reduce the casino's winnings, and therefore its profits. Logic says this is a zero-sum proposition; if player losses are limited, so are the casino's winnings. However, it remains unclear whether this proposition is accurate.

First, it is important to reflect on the tips found in virtually all responsible gambling materials: "Always gamble with money you can afford to lose" and "set a money limit." This seems to be appropriate advice, and it would be difficult to come up with an argument that loss limits are anything but responsible. However, this begs the question: what about the underlying statistics? What is the impact of the responsible gambler setting a limit on losses, but not one on winnings? Consider the scenario where a casino patron heeds the advice of the responsible gambling brochures at the casino and sets a budget (i.e., loss limit) of $500 for the casino visit. The customer begins the evening with $500 in chips, and over the course of a few hours may see wide swings in his chip count. Eventually, suppose the player has a "cold streak", which results in the loss of the entire $500 budgeted. The player stops gambling when he reaches his self-imposed loss limit, and leaves the casino.

Interestingly—and obviously—each patron who stops gambling when they have reached their self-imposed loss limit leaves the casino as a money loser. If players do not also have a win limit, and they stop only when they reach their loss limit, then it seems likely that *most* casino patrons will end up losing money at the casino. But if more players also had win limits for themselves, fewer casino patrons would lose money, and perhaps gambling-related harms would be reduced. In the following sections we develop a slot machine simulation which helps illustrate the effects of different self-imposed limits for slot machine players. Among the different "rules" we simulate are traditional loss limits, time limits and, our primary concern in this paper, win limits.

Basic Statistical Issues

Foregoing a detailed and technical statistical analysis of particular casino games, we can easily describe why the "house" wins, and what the effects of self-imposed player loss and win limits will be.[8] Each casino game is designed so that the expected value for the player is negative and for the casino it is positive (i.e., the "house edge"). Consider, for example, American roulette. The roulette wheel has 38 numbers (1–36, 0, and 00). If a player bets $10 on the number 5, for example, and a different number comes up, the player loses the $10 bet. But if the ball stops on 5 and the player wins the bet, the casino pays $350 ($35 for each $1 bet). Since the odds against spinning the 5 are 37 to 1 (there are 37 ways for the player to lose the bet, and one way to win), "fair odds" would require the casino to pay $370 to the player. The difference of $20 is a "tax" on the player, referred to as the "house edge."

One can calculate the house edge as follows. If the payoff for a winning bet is x to 1 and the true odds against the event are y to 1, then, as explained by Hannum and Cabot (2005, p. 20), the house edge is calculated as $\frac{y-x}{y+1}$. In case of American roulette, this is calculated as $(37 - 35)/(37 + 1) = 2/38$, or 5.26 %. This can be interpreted to mean that, on average, for every $100 bet on roulette, the casino will keep $5.26 in net revenue. Similar to roulette and other table games, slot machines earn profit for the casino because they are

[8] For an accessible discussion of the statistics relevant for analyzing casino games, see Hannum and Cabot (2005).

programmed to pay-out a certain percentage of the money bet, say 95 %. Over a period of time, the casino keeps about 5¢ of each $1 bet.

If, on average, the house advantage of all casino games is 5 %, then as the number of casino game plays increases, the casino's net revenue will approach the house advantage of 5 %. This result is ensured by the law of large numbers (Hannum and Cabot 2005, p. 21).[9] Consequently, the casino will make money in the long run on its casino games since the casino earns 100 % of the revenue from players' losing bets, but it pays less than true odds on patrons' winning bets.

A casino's expected revenue from its customers is illustrated in Figs. 1 and 2. The first figure shows how the casino's "win" can fluctuate. With only 100 bets placed ($n = 100$), the casino could win more than 30 % of the total amount bet or lose more than 20 % of the amount bet. But as the number of bets increases, the casino's expected win collapses around the expected value of 5 % (assuming the average house edge is 5 %). As shown in Fig. 1, the casino is certain to win when the number of bets reaches a large number, such as 10,000. Figure 2 shows a 90 % confidence interval around the amount the casino is expected to pay back to casino patrons for every $1 bet. For small numbers of play, say fewer than 50,000, the casino stands a small chance of losing money (i.e., having a payback percentage over 100 %). But as the number of plays increases, with 90 % confidence, the casino can be assured that it won't payout 100 % of the amount bet. This means that the casino profits from the casino games in the long run.[10]

Self-Imposed Limits

While the above discussion implies that a particular casino will make a profit on its casino games in the long run (i.e., as thousands of bets are placed), the particular casino patron, on a particular occasion, may either win or lose. For the player—in the short run—there is a very large variance of results around their expected loss, equal to the casino's "house edge."

Let us reconsider Fig. 1 and think of it as the player's distribution of possible results, with an expected result of about −5 % (the house edge). When a casino patron self-imposes and abides by a loss limit, as the gambler did in our example above, then the player continues gambling until they hit the left side of the distribution at the point associated with a $500 loss.[11] The patron then leaves the casino. It is in this sense that the loss limit helps to ensure that all patrons who play long enough to reach their loss limits will leave the casino as money losers. A win limit would have a similar effect, but would result in a percentage of these players instead leaving the casino while they are ahead—when they come up against the right side of the distribution, which is in positive territory.

[9] It should be noted that the typical casino player who brings $100 to the casino may end up betting much more than $100 over the course of an evening. This is because as the player wins, the winnings are often put at risk in subsequent bets. In our earlier example of a casino visit, it is possible that over the course of an evening, the patron could have bet thousands of dollars, even though he ended up losing only $500 to the casino.

[10] That is, the casino profits strictly from the casino games. If labor or other operating costs are exorbitant and more than offset the casino's profits from the games themselves, then the overall casino operation could be unprofitable. Obviously, some casinos have not been successful, despite the statistics of their business.

[11] We recognize that the figure shows percentages on the horizontal axis. However, the reader can simply imagine the horizontal axis being shown in a monetary scale; the fundamental point here does not depend on the scale for the horizontal axis.

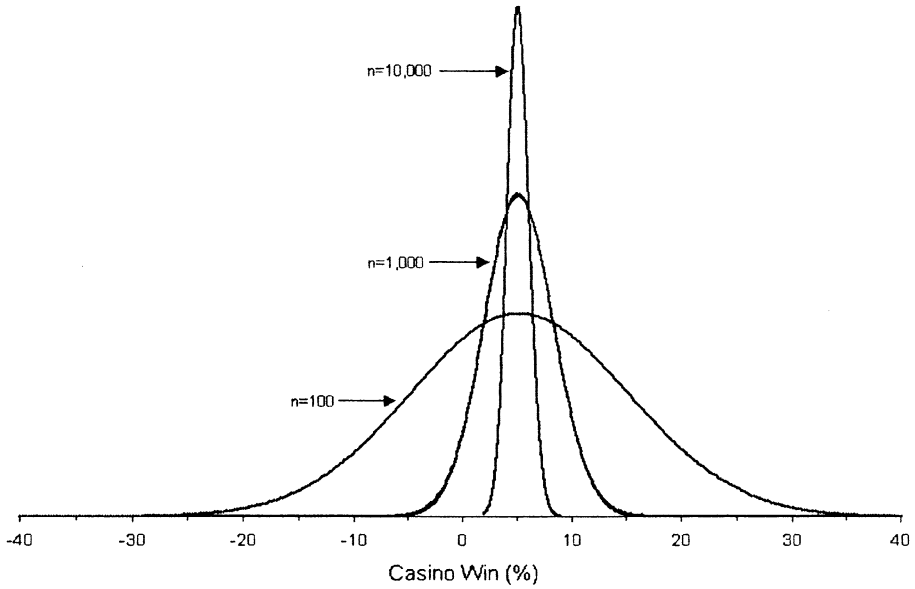

Fig. 1 Probability distribution illustrated for bets with a house advantage of 5.26 %. *Source*: Hannum and Cabot (2005, p. 22)

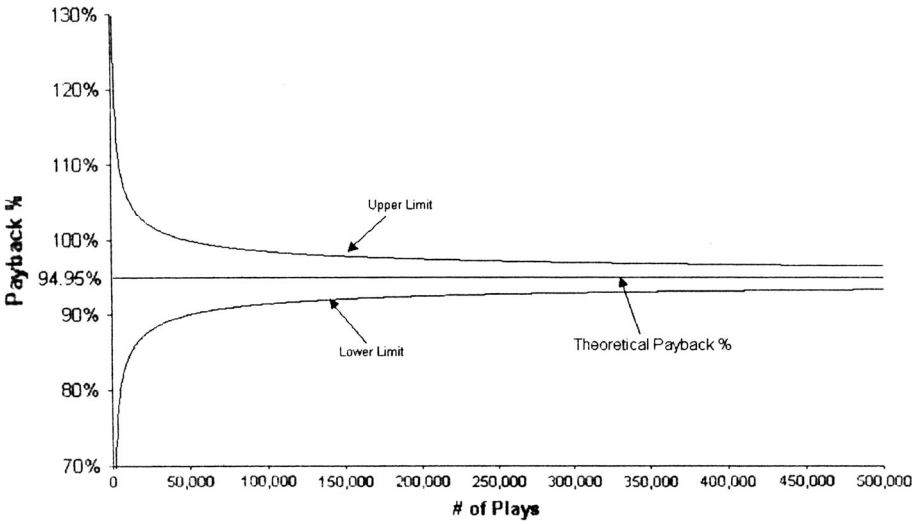

Fig. 2 Casino payback percentage (expected value of 94.95 %), with 90 % confidence band. *Source*: Hannum and Cabot (2005, p. 73)

In this case, the player wins and the casino loses money to that player. For a lower number of plays, the player has almost as good a chance of leaving the casino winning as losing, if both win- and loss-limits are used.

Table 2 Simulated slot machine spin results and payoffs

Random number		Net payoff
Minimum	Maximum	
0.00000	0.75000	$(1)
0.75001	0.90000	$0
0.90001	0.97000	$1
0.97001	0.99897	$20
0.99898	0.99997	$45
0.99998	1.00000	$160
Overall expected value: $(0.05)		

Casino Simulation

In order to test the effects of loss limits, time limits, and win limits, we set up a slot machine simulation. We use a random number generator (0.000–1.000) to determine the results of the slot machine spin. The simulated slot machine requires a $1 bet, and allows only one play per spin (i.e., $1 is at risk on each play/spin).[12] The payoffs we set for different random numbers (spins) are shown in Table 2. Similar to a machine one might find in a moderately competitive casino market such as Las Vegas or Atlantic City, the overall expected payout from our slot machine is 95 %; or a 5 % hold (Hannum and Cabot 2005, p. 48). Thus, the casino patron should expect to lose an average of $5 for every $100 bet on the machine.

Table 2 shows the *net result* from each play. For example, 75 % of the time, the player will put in $1 to play the machine and lose the dollar. The player gets his dollar back 15 % of the time, for a net payoff of $0 (second row, Table 2), and so on. If the random number generator produces 0.99900, the player's net payoff is $45 (his $1 is returned, plus $44 of the casino's money).

Each run of the simulation has 60 individuals playing slot machines. The simulation will allow each player to make up to 5,000 slot machine spins if there is no limit set to stop the player sooner. We ran 15 rounds of each simulation. Thus, we have 900 simulated casino patrons playing slot machines under each scenario. We assume that all players adhere to the self-imposed betting limits under each simulation.[13] A summary of the simulation results is presented in Table 3. Next we explain the details of each simulation, as well as the key findings.

Simulation 1: No Win or Loss Limits

In the first scenario, the players have no win, loss, or time limits. However, each simulation run allows 5,000 slot machine spins for each player. We believe these are adequate spins—about 8.33 h of play if each spin takes 6 s—to show what happens for the player in "the long run".[14] This amount of play seems reasonable for a casino patron making a weekend

[12] Of course, the typical gambler probably does not make uniform bets. However, we hold this variable constant to isolate the effect of betting limits on outcomes.

[13] The extent to which gamblers adhere to pre-commitments on gambling under different betting limits is an interesting topic, which could be addressed in an experimental study. However, it is beyond the scope of this paper.

[14] However, as suggested by Fig. 2, only when the player makes thousands of spins will their probability distribution collapse tightly around the expected value of −5 %.

Table 3 Summary of simulation results, 900 players

	Simulation	# Winners (% chance of winning)	Average $ result	Minimum $ result	Maximum $ result	Average time played (# plays[a])	Minimum time played (# plays[a])	Maximum time played (# plays[a])
1	No win or loss limits (5,000 spins; 8.33 h of play[a])	159 (17.6 %)	$(251)	$(843)	$419	8.33 h (5,000)	8.33 h (5,000)	8.33 h (5,000)
2	Time limit of 1 h[a]	315 (35.0 %)	$(30)	$(220)	$233	1.0 h (600)	1.0 h (600)	1.0 h (600)
3	$100 loss limit	66 (7.3 %)	$(76)	$(100)	$382	2.38 h (1,429)	0.25 h (147)	8.33 h (5,000)
4	$100 loss limit; $100 win limit	275 (30.6 %)	$(35)	$(100)	$162	1.13 h (677)	0.13 h (78)	4.33 h (2,595)
5	$100 loss limit; $100 win "down"	286 (31.8 %)	$(35)	$(100)	$666	1.22 h (730)	0.07 h (41)	8.33 h (5,000)
6	$100 loss limit; $200 win limit	135 (15.0 %)	$(53)	$(100)	$254	1.81 h (1,084)	0.26 h (156)	7.46 h (4,478)
7	$100 win limit	435 (48.3 %)	$(153)	$(858)	$186	5.23 h (3,135)	0.14 h (81)	8.33 h (5,000)

[a] This assumes each spin/play takes 6 s

visit to a casino. As shown in the first row of Table 3, there will be 159 out of the 900 players (17.6 %) who end up winning money at the end of 5,000 spins, or 8.33 h of gambling. This winner percentage is somewhat larger than the 11–13 % suggested by in recent studies (Maremont and Berzon 2013). The average result is a loss of $251, or 5 % of the $5,000 put at risk in the course of 5,000 spins. The best result is a win of $419, and the worst is a loss of $843. In this scenario, players continue taking money from their wallet to feed the slot machine if they are doing poorly. Others continue to play off of their winnings. The maximum a person could ever lose under this scenario is $5,000. However, this is virtually impossible since it would mean they never won a single spin of the 5,000 spins played.

Simulation 2: Time Limit of 1 h (at 6 s per Play = 600 Plays[15])

One strategy of "responsible gambling" is to limit one's time gambling. For this simulation we limit each player to 1 h, or 600 plays, assuming each play takes 6 s. With a time limit in place, 35 % of players (315 of 900) leave the casino as money winners. The average result is a loss of only $30. Both minimum and maximum results are smaller than in simulation 1. The results of this simulation support the obvious notion that the less a person plays at a casino the less money they are expected to lose. Among all the simulations, this one yields the smallest average loss because it limits the number of plays the most of any simulation. It is important to note that for many casino patrons limiting the time played will also limit the enjoyment derived from gambling. So although the losses are smaller, so is the amount of time spent gambling, presumably an enjoyable activity to most (non-problem gambler) casino patrons.[16]

Importantly, each of the subsequent simulations (3–7) effectively limit the amount of time a person gambles. Therefore, all of the simulations with limits imposed (on time, losses, or winnings) have lower average losses than in simulation 1, with only the 5,000 play limit.

Simulation 3: $100 Loss Limit

Simulation 3 follows the responsible gambling strategy of setting a loss limit. We place a $100 loss limit on each player, but no win limit or other restrictions. Each player stops once he has lost $100 (or makes 5,000 spins, whichever comes first). In this scenario, no player can lose more than $100 out-of-pocket. As shown in Table 3, row 3, there are only 66 winners out of the 900 players (7.3 %)—by far the lowest of any simulation—but the average loss of $76 is less than that from the unrestricted simulation 1, $251. The average number of plays under simulation 3 is 1,429, which would take about 2.4 h.

Simulation 4: $100 Loss Limit; $100 Win Limit

In scenario 4 we introduce a $100 win limit in addition to the $100 loss limit. A player thus stops gambling when he either goes up or down by $100. With both the loss and win limit, 30.6 % of players win (275 out of 900); recall that with the loss limit only 7.3 % of players win. Thus, the win limit causes the number of winners to quadruple over the loss limit

[15] We set 6 s per spin arbitrarily. It seems reasonable, but of course, actual games could be slower or faster than our simulated slot machine.

[16] This issue is addressed in the next section.

alone. The average loss in this simulation is only $35, but the maximum gain is also the lowest ($162) of any scenario.[17] Under simulation 4 there will be an average of 677 plays (about 68 min of play) until a person reaches either the win or loss limit.

Simulation 5: $100 Loss Limit; $100 Win "Down"

This simulation is very similar to the previous one, with one difference. In simulation 4, the player stopped as his winnings increased to $100. Simulation 5 also imposes a $100 win limit, but the player stops as he reaches the limit on the way down. For example, if a player has $80 and wins a $45 jackpot, his balance will be $125. Under this simulation, the player keeps playing until his balance *falls to* $100. Then he stops. This scenario results in 31.8 % of players winning, a result close to the previous simulation. While the maximum loss is the same, players can end up with higher winnings. On average, players engage in about 5 min more play than in the previous scenario.

Simulation 6: $100 Loss Limit; $200 Win Limit

As a modification of simulation 4, we next impose a higher win limit, of $200. Although we could consider an infinite number of simulations, we choose this one because one might argue that the win limit need not be as strict, since winnings will benefit the player. The higher win limit enables the average player to play longer. However, the average loss is more than under simulation 4, since the player is likely to hit the loss limit before the win limit. We also note that relatively few players (15 %) win under this scenario, but the tradeoff is that they are able to gamble longer (an average of 1.8 h) before reaching one of the limits.

Simulation 7: $100 Win Limit

For our final scenario, we tested what would happen with a $100 win limit but no loss limit. This is certainly not a strategy commonly suggested for responsible gambling. Yet, the most striking result of this simulation is that almost half of the players win (48.3 %). The average loss of $153 is the second worst of all simulations, and the minimum result of −$858 is the worst of any simulation. However, under this scenario, the average player enjoys more time playing (5.2 h) than any other simulation with a limit.

Discussion

The effects of pre-commitments, such as loss limits, have been analyzed previously in the literature. Such rules limit the time spent playing and the amount the casino patron loses at the casino. However, win limits have not yet been explored in the literature. The results of the different simulations tested in this paper confirm that win limits would reduce both gains and losses for average players. Compared to a $100 loss limit only (Table 3, simulation 3), a $100 win and loss limit (simulation 4) reduces the average loss by about 53 %.

[17] The minimum result in scenario 3 is −$100 because the player can lose at most $1 per play. The maximum result can be over $100 even with the $100 win limit because the player can win $20, $45, or $160 on a single spin. Therefore, the minimum number of plays (78) for simulation 4 occurs because a person won a jackpot and that pushed his total winnings over $100.

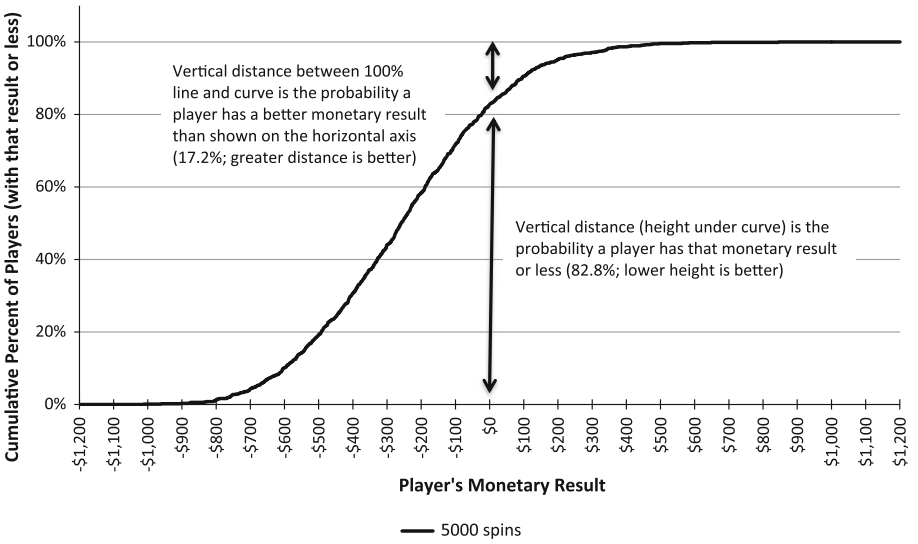

Fig. 3 Cumulative density function (CDF) for 5,000 slot machine plays

A $200 win limit coupled with a $100 loss limit (simulation 6) reduces the average loss, compared to the loss limit alone, by about 30 %. In addition, win limits significantly increase the number of eventual winners, simply because players stop when they reach the win limit; they do not lose all their winnings back to the casino.

When we compare the two different types of $100 win limit (simulations 4 and 5), we see that they provide roughly the same result, except that when the win limit is applied "on the way down," the maximum result is much higher than if the player stops at a $100 gain on the way up. The win limit "down" also results in slightly more time played, on average, as well as a larger maximum time played. Comparing two different size win limits ($100 and $200; simulations 4 and 6), the stricter win limit in combination with the loss limit results in about twice as many winners as the $200 win limit. This is because fewer people will ever reach the $200 limit than the $100 limit. In addition, the average loss is much greater ($53) with the $200 limit than the $100 limit ($35). However, the average player takes over 300 more spins when using the higher win limit. Lastly, we consider simulation 7, which has a $100 win limit only. As noted above, this strategy results in the most winners (48.3 % of simulated players), but the average result is second lowest ($153) only to betting with no limits. The average time played is second highest to having no limits. This strategy increases time played compared to all other betting limits and increases one's chance of leaving the casino as a winner, but is coupled with the risk of having the highest loss of the simulated betting strategies.

Cumulative Density Functions

A visual comparison of the different limits is helpful to consider. As a benchmark, Fig. 3 illustrates the cumulative density function (CDF) for the unrestricted simulation (5,000 spins, or 8.33 h of slot machine play). The height below the curve represents the probability that a player has a monetary result equal to or worse than that indicated on the horizontal axis. For example, the arrows aligned above $0 indicate that 82.8 % of players

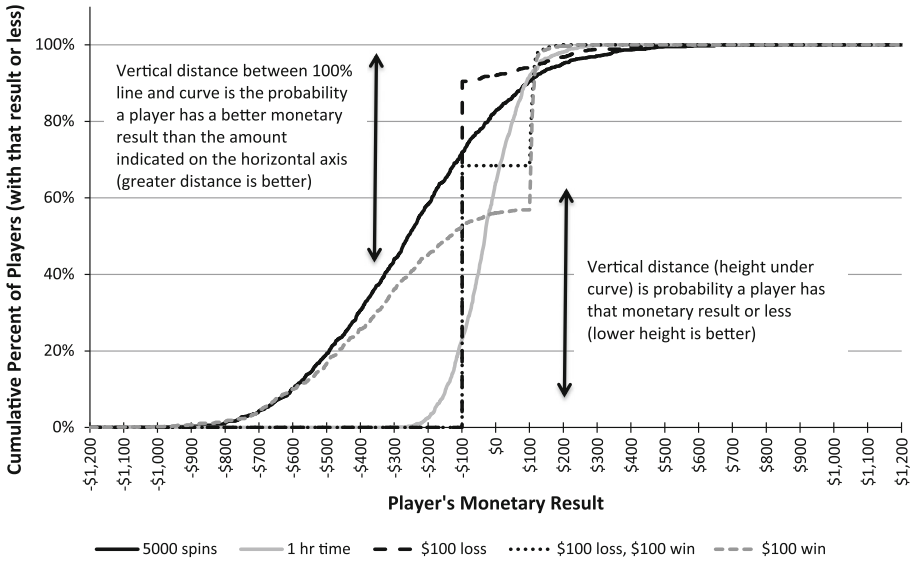

Fig. 4 Cumulative density functions (CDFs) for different betting rules

will have monetary losses. (That is, a given player has an 82.8 % chance of losing money after 5,000 spins.) The vertical distance above the curve and below the 100 % line represents the probability a player will have a better monetary result. In this case, players have a 17.2 % chance of being in winning territory after 5,000 plays.[18]

In Fig. 4 we present a comparison of selected simulations from above. The figure illustrates the CDFs for the benchmark no-limit case (from Fig. 3), a 1-h time limit, a $100 loss limit, a $100 loss/$100 win limit, and a $100 win limit. (The figure shows the CDFs for simulations 1, 2, 3, 4, and 7.)

The best interpretation of Fig. 4 depends on the reader's perspective. For example, a casino patron might be interested in maximizing his chance that he leaves the casino as a winner. Among our simulated strategies, the patron would want to follow the $100 win limit, as the distance above the CDF at $0 is the greatest with that strategy. Interestingly, the loss limit would be the worst strategy for this patron. On the other hand, a psychologist who is promoting responsible gambling might want to suggest the strategy that minimizes the number of people who lose more than $100 on a particular casino visit. For this goal, "no limit" and "win limit" are the worst strategies. Notably, the $100 loss/$100 win limit assures that players do better, on average, than the $100 loss limit by itself.

Time Played

It should be reiterated that monetary losses and winnings are not the only important consideration. Most casino patrons enjoy playing casino games. Hence, time played is for many gamblers an important consideration. In Table 3 we provided data on the average, minimum, and maximum time played. Figure 5 illustrates these data, arranged from minimum to maximum average time played under the different simulations. A casino

[18] There is a very small probability that a player will break-even.

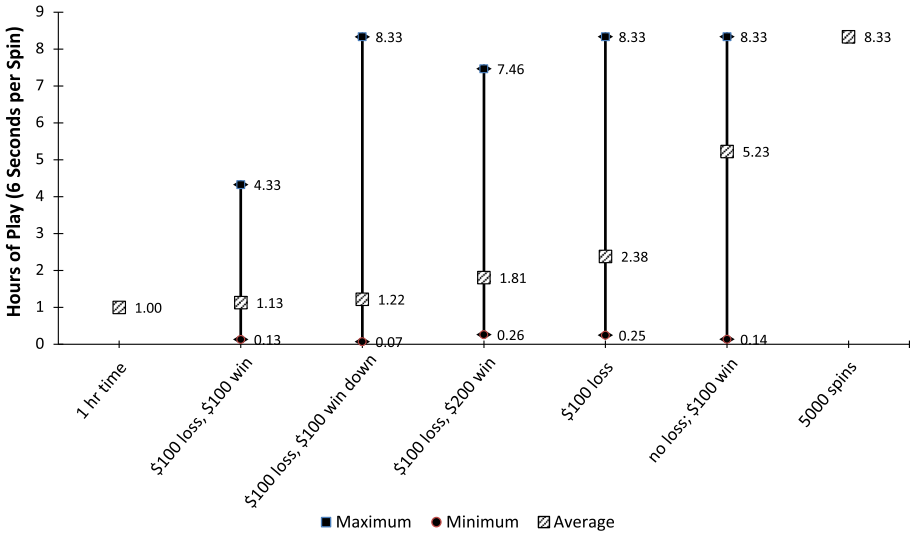

Fig. 5 Time played under different betting rules, arranged by average time played

patron might want to incorporate a win/loss limit strategy, but also want to maximize time played. The best rule to maximize playing time with a limit is the $100 win limit, under which the average player would play for 5.23 h. A player who wants to maximize time played, but also wishes to limit losses to $100 should choose the $100 loss limit.

As noted earlier, the basic effect of loss limits and win limits is to reduce the amount of time the casino patron gambles. Since the games are designed to have a negative expected value (from the player's perspective), a reduction in time played will reduce the average player's loss amount. The effect of a win limit on the casino's bottom line can be considered on a per-patron basis. Since our simulation includes many (900) players acting according to each simulated betting rule, the casino's revenue is simply the casino patron's average result. That is, from Table 3 we can see that a player who makes 5,000 plays will, on average, lose $251. Thus, the casino earns $251 from this patron. When a player uses a $100 loss limit, the casino can expect to make $76 in revenue on average. If a $100 win limit is used in addition to the loss limit, the casino earns only $35. Without making assumptions as to the number of casino patrons who set and adhere to betting limits, we cannot forecast any aggregate effect on the casino's bottom line. However, it is clear that since betting limits reduce time played, all such limits have the effect of reducing casino revenues compared to a case in which patrons set no betting or time limits.

A Casino Patron's Utility Function

It is clear that there are potential positive and negative impacts of self-imposed gambling limits. For some patrons, limiting losses may be a priority. Others may wish to dampen losses, while maximizing time played. Which of the simulations tested provides the "best" result depends on one's goal. We can generalize the total value of a player's casino experience in monetary terms. Let V_T be the total dollar value of a player's casino

experience, that is the sum of two things, the financial net winnings (W), and the enjoyment value of the time spent playing (t, in hours), valued at V_H value per hour:

$$V_T = W + t * V_H \tag{1}$$

The expected value outcome for the average player can be found by taking the expectation of equation (1), E[·] as follows:

$$E[V_T] = E[W] + E[t] * V_H \tag{2}$$

The three variables are now in expected values and the exogenous value the gambler places on time played is a constant.[19]

The impact of imposing a betting limit can be thought of in terms of how it changes (Δ) the three endogenous terms:

$$\Delta E[V_T] = \Delta E[W] + \Delta E[t] * V_H \tag{3}$$

For example, a win limit will increase the player's value of playing casino games (V_T), if and only if:

$$\Delta E[W] + \Delta E[t] * V_H > 0 \tag{4}$$

Because the effect of a win limit (coupled with a loss limit) is to increase the expected monetary result ($\Delta E[W] > 0$) but to decrease time played ($\Delta E[t] < 0$), rearranging terms yields:

$$-\frac{\Delta E[W]}{\Delta E[t]} > V_H \tag{5}$$

Thus, the win limit will increase the player's net total value of gambling only if the expected increase in financial net winnings divided by the time lost exceeds the value the player places on time spent gambling. As a numerical example, consider our simulation results. Suppose a casino patron changes from having a loss limit only (simulation 3) to having both a win and loss limit (simulation 4). As can be seen by comparing the results of simulation 3 and 4 in Table 3, the addition of the win limit increases the financial result (i.e., reduces expected loss) by \$41, but results in 1.25 h less time playing (on average). The addition of the win limit would improve total value for the player if and only if they value their time spent playing at less than \$32.80 (calculated \$41/1.25 h). If the casino patron valued their time playing at \$10 per hour, for example, the 1.25 h playing lost would reduce value by \$12.50 but because the win limit increases expected financial net winnings by \$41, the player would be \$28.50 better off with the win limit than with just the loss limit. Alternatively, if the player valued their time gambling at \$40 per hour, the 1.25 h gambling lost would reduce total value by \$50, while the win limit increases expected net financial winnings by \$41, leaving the player a net \$9 worse off.

Using our simulation results we can compare the patron's total value of the casino experience (V_T), depending on how their enjoyment value per hour (V_H) varies. When V_H is between \$1 and \$22, a time limit of 1 h (simulation 2) is the best strategy. For V_H between \$23 and \$29, the \$100 loss limit/\$100 win "down" strategy (simulation 5) is best.

[19] In our simulations, E[W] = − 30t, since the expected value of each \$1 spin is −5 %, and we assume there are 600 spins per hour. For the discussion here, we leave E[W] in general terms. If E[W] is −30t and casino patrons know that the house edge is 5 %, then we would expect their V_H must be at least \$30 per hour; otherwise, they would not sit down to gamble.

For V_H of \$30 or \$31, the \$100 win limit is best. If V_H is \$32 or greater, the "no limits" strategy is best. Interestingly, there is no V_H for which the \$100 loss limit (simulation 3) is the superior strategy. At V_H less than \$27, the loss limit ranks fifth of the seven simulations. At V_H of \$30–32, a loss limit is the *worst* strategy. However, for V_H at above \$5, the loss limit ranks average (third or fourth) among the seven simulations.[20]

Clinicians and researchers may suggest that problem or at-risk gamblers do not have a positive value for time playing casino games, as gambling may be more of a compulsion than a rational choice.[21] The implication in this case is that time played should be minimized, since that would reduce both expected monetary losses E[W] and time spent gambling, E[t]. There are modifications to the utility function that could lead to different conclusions. For example, we could consider decreasing marginal utility from gambling and the potential to become addicted (as a negative argument in the utility function). Additionally, the number of gambling sessions, not just the time spent gambling, might affect a person's utility. Nevertheless, the fundamental point is that with any of the betting limits considered, there are tradeoffs with respect to overall chance of winning, average losses, and time played.

Effect of a Win Limit on the Casino Experience

We can anticipate why win limits may not be embraced by gamblers, even responsible gamblers. The win limit fundamentally reduces the time spent gambling. Many casino patrons visit a casino with the primary goal of spending time gambling, with their win/loss amount being of secondary importance. The responsible gambling literature recommends going to a casino with friends. This is responsible, but just because one person hits their win limit does not mean the others would be ready to leave the casino. It may simply be difficult for people to leave once they have reached their win/loss limit. Aside from this, we can point to three potentially negative psychological effects associated with the strategy. First is the feeling that losing "house money" is not irresponsible, and that playing with this "free money" is one's best shot for a big win. This may make it difficult for an individual to leave the casino once they have reached a self-imposed win limit. Second, problem gamblers may be focused on chasing previous losses. It would likely be difficult for these people to stop gambling just as they begin winning. Third, responsible gambling is about keeping players from losing more than they can afford and preventing excessive gambling. It may be emotionally painful for a player to reach their loss limit. Walking away with a similar magnitude of winnings, however, will bring only limited pleasure, as prospect theory would suggest.

If win limits were added as a strategy for responsible gambling, perhaps it should be suggested that the casino patron should leave the premises for at least a few hours. The time away may cause the person's conception of their casino winnings as the "house money" to change to their own money since they have time to contemplate what else they could do with the money they have won. In other words, away from the casino, a person's

[20] We ranked each of the "strategies" (i.e., simulations) based on V_T given different values of V_H. The full results are omitted for brevity, but they are available from the authors upon request.

[21] Some economists argue that addicts still benefit from the consumption of the addictive good. This controversial argument is based on the theory of rational addiction (Becker and Murphy 1988), which suggests that past consumption reinforces future consumption.

mental accounting might conceive winnings as their own money, rather than "house money" that they are holding only temporarily.[22]

Another potentially interesting effect of a self-imposed win limit is that the decision to walk away from the casino when ahead may be difficult because playing and potentially losing "house money" does not have as serious a monetary consequence as losing one's own money does. Therefore, making the decision to stop playing once the win limit is reached may be an effective strategy at helping at-risk casino patrons learn to make other difficult choices, such as limiting their losses and exposure to casinos. This may ultimately make "responsible gambling" a more common practice and more effective.

Conclusion

In the book, *Change Your Gambling, Change your Life*, Shaffer et al. (2012) offer practical advice to readers who may be trying to cope with a gambling problem. These authors write, "Not surprisingly, many people who have gambling problems are also in debt. In fact, few people who gamble ever win more than they lose" (p. 51). Our simulations suggest that this would be a less certain conclusion if more people used win limits.

Gaming corporations are doing the socially responsible thing when they ask their guests to play responsibly. The dangers of excessive loss have real and documented negative consequences. Gamblers need to quit when they have lost all they can afford to lose. The results of this study suggest casinos should also begin to promote win limits as a strategy of responsible gambling. The casino is doing right, likely caring about their guests and being socially responsible, by encouraging loss limits. Win limits, though detrimental to the casino's profits, would seem to be equally responsible.

There has been published research on loss limits and time limits. However, the potential usefulness of win limits as a strategy of responsible gambling has not been explored. The purpose of this paper is to provide a simulation to illustrate the potential benefits of win limits for the advancement of responsible gambling practices. We hope that this paper provides a catalyst for researchers and clinicians to test the impacts and effectiveness of self-imposed win limits on gamblers. Although our simulation suggests that win limits may be useful for simple slot machine games, more research is needed to determine whether the results would be significantly different for other types of games (e.g., EGMs with a jackpot component, games including an element of skill such as poker and blackjack). Intuitively, we would expect the win limit strategy to work across game types since it fundamentally reduces time played, which should reduce expected losses in all casino games. However, the literature suggests that limits may not be as feasible for some games that do not provide game-related feedback (as a slot machine does). Future research in a laboratory or experimental setting could also examine the psychological effects and experiences associated with win limits. For example, it would be interesting to know whether players would be more likely to abide by self-imposed win limits or loss limits, and which, in practice, would result in less harm for at-risk gamblers.

Acknowledgments We are grateful to Jeffrey Derevensky, Ph.D. for helpful comments and suggestions.

[22] The paper by Thaler and Johnson (1990) examines how people behave differently when playing with "house money". One potentially interesting area of study would be the time frame over which house money transforms into "own money" in one's mental accounting.

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