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# THE APPLICATION OF COMPUTER SIMULATIONS IN EXPLORING CONTINUOUS CONSUMER BEHAVIOUR: THE STUDY OF GAMBLING BEHAVIOUR

There are many industries with customers whose consumption activities are undertaken on a continuous or long-term basis can have more severe consequences financially and personally if the consumer has misconceptions of the relationship between their behavior and its outcome. The service providers in many of these industries are able to track consumption behaviours on an aggregate level. This paper illustrates using research conducted into gambling behaviour, how in these circumstances, Monte Carlo simulations can provide reliable estimates that can be useful to both marketers and policy makers.

## Marketing, Simulations, Gambling

In general humans are notoriously poor at accurately identifying and reporting on their own behavior and the effects of their behavior. There are circumstances under which consumer estimates can be highly predictive of actual behaviour (e.g. when asked to refer to specific behaviours in memory). However, errors are incurred when individuals try to rationalize or explain outcomes as it relates to their behaviour (e.g. report on processes that are not in memory) (Aloba and Hutchinson, 1987; Barcley & Wellman, 1986; Brenner, Koehler, Liberman, & Tversky, 1996; Buehler, Griffin & Ross, 1994; Carlson, 1993; Tversky & Kahneman, 1983). When it comes to the purchase of most consumer products, the consequences of these inaccuracies are relatively small in particular for those purchases that tend to be discrete rather than ongoing or continuous in nature. However, some consumption activities that are undertaken on a continuous or long-term basis can have more severe consequences financially and personally if the consumer has misconceptions of the relationship between their behavior and its outcome. This includes transactional interactions that can have a cumulative impact on the consumer such as gambling, alcohol and tobacco consumption, buying on credit, long distance or cellular phone use, home energy consumption. In these circumstances reliance on traditional methods of measuring behaviour often prove inadequate and innovative approaches are required in order to understand complex behavioural antecedents and the implications of such behaviour for the consumer.

In regulated industries it is even more imperative for policy makers and marketers to know and understand consumer behaviour so that their products and/or services can be marketed responsibly minimizing the opportunities for abuse or misuse by the consumer. This is especially relevant for the gaming industry as severe negative consumer consequences can accumulate fairly quickly for those affected. When it comes to gambling, especially continuous random forms of gambling like VLTs, consumer ability to understand the consumption process, to estimate their own behaviours, and judge the consequences of those behaviours has been shown to be very inaccurate (Doherty, Chadwick, Garavan, Barr, & Mynatt, 1996; Gibson, Sanbonmatsu, & Posavac, 1997; Gilovich, 1983; Gilovich & Douglas, 1986; Levin, Chapman, & Johnson, 1988; Sanbonmatsu, Akimoto, & Biggs, 1993). In such situations the decision maker attempting to understand and mitigate those factors influencing negative outcomes typically has only two sources of information to rely upon. First, customers estimation of their own behaviour, and second, regulator mandated statistics or machines records which generally are compiled and tracked at an aggregate rather than individual level.

These two sources of information allow the researcher to derive estimates of critical parameters necessary for decision-making. However, often they are insufficient and there are gaps in knowledge or uncertainty in estimates that need to be clarified. In the gaming industry large gaps exist in knowledge concerning play behaviours and the impact on the player in terms of losses over an extended period of time. Efforts by industry regulators to understand the possible impact of various game changes, modifications or policy changes are hampered by the lack of information available at the per session and player levels. In particular there is a lack of understanding of the play characteristics and game outcomes that lead to problem gambling and these areas need to be explored further.

The remainder of the paper illustrates an application of a computer simulation to fill the gap in knowledge concerning the play behaviours of different segments of gamblers. This information could not be derived from existing survey and gaming industry data, although both are important inputs in the simulation model.

## The Issues

In the 1997/98 Nova Scotia Video Lottery Players Study, prepared for the Department of Health, by Focal Research Consultants Ltd. (Nova Scotia Department of Health & Focal Research Consultants Ltd, 1998), it was stated that "Problem Video Lottery Gamblers, because of the nature of their play patterns, will likely incur lower cash out than do non-problem Video Lottery (VL) players." If this is true, the play behaviour of the Problem VL Players means that not only do they spend more than other VL players, but that they also lose a greater proportion of their expenditures when playing the machines. The authors undertook additional analysis to determine whether Problem VL Players do incur lower cash out percentage than other players, and to identify the factors contributing to any differences in cash out percentages.

A second issue also needed to be analyzed. The Nova Scotia Alcohol and Gambling Authority annual report had for years been reporting the cash out rate for VLTs play in Nova Scotia to be around 70% (Nova Scotia Alcohol and Gaming Authority, 1998). The authority had the Atlantic Lottery Corporation keep track of total credits purchased at the machines, and total credits cashed out at the machines, so the numbers reported were valid and reliable. However, these numbers were in direct contradiction to the numbers reported by the players. The authors had, over the previous six years, conducted numerous focus groups with regular VL Players who consistently reported cash out rates of between 30% and 50%. In developing the simulation model we would explore this discrepancy. Our feeling was that it had to do with specific behaviours of the players that they could not articulate or quantify very well and that had been missing from our model of player behaviour.

## Approach

The survey providing the input estimates for the simulation was the 1997/98 Nova Scotia Video Lottery Players Study (Nova Scotia Department of Health & Focal Research Consultants Ltd, 1998). This survey had required a household screener administered to 9,339 Nova Scotia households (response rate 79.9%) in order to identify Regular VLT Gamblers (Regularly played VLT machines once a month or more) among 18,651 adults. Once identified, all Regular VLT Gamblers in the household were surveyed resulting in 711 completed surveys (76.7% of those identified). As well, a sample of 400 Nova Scotia adults (61.1% response rate) was surveyed to provide a benchmark for behaviours in the general adult population.

There were three segments of regular VL players analyzed in the report; Infrequent Players who play VLT games one to three times each month, on average; Frequent Players who play four or more times each month, on average; and Problem VL Players. Table 1 presents a profile of the three segments in terms of play behaviours (Nova Scotia Department of Health and Focal Research Consultants Ltd, 1998b).

**TABLE 1 Video Lottery Player Segment Profiles**

| Characteristic | Infrequent N = 327 | Frequent N = 267 | Problem N = 117 |
|---|---|---|---|
| % of Regular Players | 46% | 38% | 16% |
| Total Revenue Contribution | 10% | 36% | 54% |
| Amount Put into the Machines Initially | \$5.49 | \$5.88 | \$12.34† |
| Average Credits Each Spin | 11.0 | 12.0 | 18.5† |
| Average Minutes per Session | 43.3† | 66.8† | 150.1† |
| Average Expenditure per Session | \$16.33† | \$29.44† | \$82.24† |
| Spend All Money Brought 50% of Time or More | 53% | 54% | 81%† |
| Obtain More Money in Order to Play 25% of the Time or More | 6% | 13% | 51%† |
| Spend More Than Intended in Order to Win Back Losses | 7% | 13% | 69%† |
| Will Reinvest \$20 VL Win Back Into Additional Play | 26% | 34% | 74%† |

*a. Infrequent Gamblers account for 10% of revenue generated by regular gamblers in Nova Scotia*
*† p < .10*

To address the issues, it was necessary to model the play behaviours for the problem and each of the non-problem players segments, in order to derive comparative cash out percentages. A VLT Simulation Program in Visual Basic was developed to facilitate the analysis. This simulation program was designed to determine the relative impact of play behaviours on the cash out percentage and to test alternative play strategies that had been suggested in pilot studies leading up to the Problem VL Gambler's analysis. The results of the simulation (i.e., outputs) summarize player expenditures, wins, losses and other related measures, including those currently monitored on an aggregate level (prize payout and cash out percentage) by the Provincial regulatory agency, as well as information which is not (yet) available from the machine data (cash back percentage, win/loss percentage).

**Key Concepts**

There were four key concepts that were relevant to the analysis:

**Cash Out -** The term cash out refers to the total amount of money that is taken out of the VLT machines (i.e., cash slips) as a percentage of the total amount of money put into the machines. The machines currently track this cash out percentage as "coin in" versus "coin out" or, more specifically, total credits cashed out of the machines as a proportion of the total credits wagered. In the 1997-1998 NSAGA Annual Gaming Report (page 24), it was reported that in 1998 that the cash out for the province was 70.3%, based on \$404 million in credits put into VLT machines, while \$284 million in credits was cashed out in the form of slips. The difference, \$120 million, is the money generated in Nova Scotia by VLT gambling.

**Prize Payout -** The second term that needs to be defined is prize payout. The average prize payout refers to the amount won every time a player spins the reels or draws a hand. If a player bets \$1.00, on average, how much will he or she win back for that hand or spin? In 1998, the answer was $0.9504, or 95.04% of the money bet each time. If the player wins back 95% the first spin, and then bets that same money again, he/she will win another 95% of the 95%, and so on. The reason the money they put in lasts for so many spins is because they only bet a portion of it at a time, for example, $1.00. That means on a $1.00 bet they will lose, on average, $0.05 a spin. At that rate, it takes a while to spend the $10.00 they may have put into the machine.

Thus, in Nova Scotia at this time, on average, there is a -5% expected value for players in terms of prize payout for each "spin" or play on a video lottery terminal. However, despite a 95% prize payout on a per spin basis, on average, players cash out approximately 70% of the total amount wagered. It is noteworthy that this average cash out percentage is similar across other jurisdiction in Canada even though there are different provincial prize payout percentages.

This means that in 1997, according to the prize payout, VL players in Manitoba lost almost twice as much as those in Nova Scotia on a per spin basis (NS: -4.7% versus Manitoba: -7.3%) yet, the average cash out percentage in both provinces was virtually identical (.71.7% versus .71.8%) (1997/98 Annual Gaming Report, NS Alcohol & Gaming Authority - Volume 1, Chapter 2, 25). Thus, it appears that factors other than just prize payout are influencing the cash out percentages. The simulation would be able to explore the behaviours that lead to this evening out of Cash Out regardless of average Prize Payout.

**TABLE 2 Cash Out and Prize Payout Figures for Three Provinces**

| 1997 Fiscal Year | Nova Scotia | Saskatchewan | Manitoba |
|---|---|---|---|
| Average Cash out | 71.7% | 67.9% | 71.8% |
| Average Prize Payout | 95.3% | 91.7% | 92.7% |

**Cash Back** - A third concept that must be introduced is that of the cash back percentage. For the purpose of this paper, cash back refers to the amount of money players cash out of the machines and walk away with at the end of a play session as a percentage of what they have spent out-of-pocket on their VL play. For example, if they put in $10.00 out-of-pocket and walk away with $5.00 at the end of the play session, their cash back percentage will be 50%.

The policy makers are relying on available figures to estimate the average cost to players of playing, based on their input into the machines. The only available figures were the total credits wagered, and the total credits cashed out, allowing the policy makers to produce the cash out figure of 70.3%. At this time, video lottery machines are not designed to identify individual players or play sessions. Therefore, it is not possible for cash back percentages to be identified using the figures currently available from the VLT machines. It was therefore necessary to develop a simulation, which would allow for the calculation of Cash Back based on the play behaviours of each player segment.

**Development and Validation of the Simulation Model**

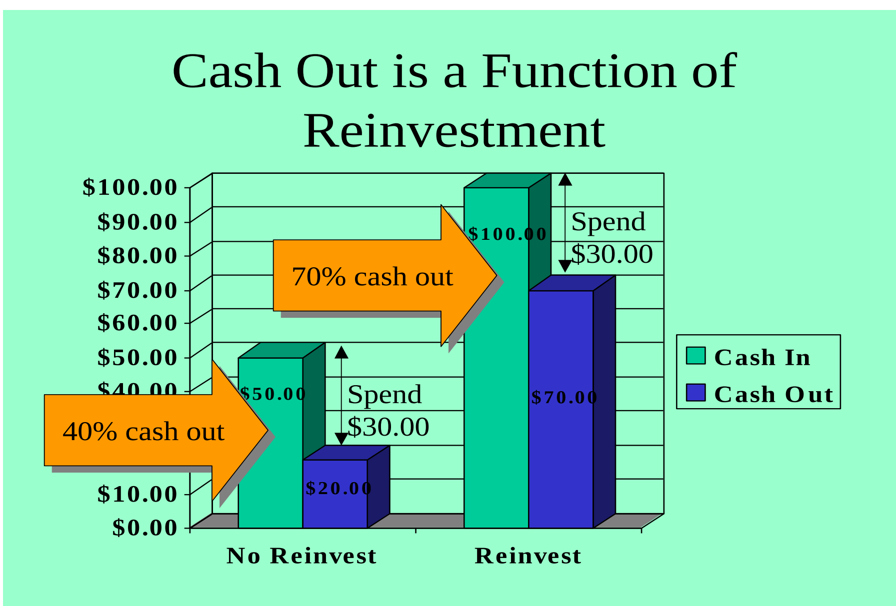
The simulation mimicked the play session of an eight-line match up VLT game that accounts for the vast majority of revenue from the Nova Scotia VLT machines. The preliminary model included inputs that specified game characteristics and play characteristics that allowed us to simulate a typical play session. It was necessary to first establish internal validity and consistency at a per player level before using the simulation to predict player segment results and total provincial figures. Specifically, the model had to produce average expenditures for each segment that corresponded to those found in the survey. At the same time it had to provide cash out levels that, when averaged over the three segments, agreed with the reported cash out level for the total province. In developing the simulation several unknown aspects of play were identified.

First, it was not possible to achieve cash out figures even close to 70%. The outputs at this stage correctly mirrored the actual pay out percentages (95.04%) and average expenditure per segment. However, repeated adjustments to the play behaviour inputs could not produce a 70% cash out rate. The highest possible payout rate achievable was around 50%, but the input values necessary to reach these levels were not representative of normal play behaviour.

Examination of the inputs and outputs of another simulation, the PC EGMSim simulation software for an Australian Electronic Gaming Machine (Australian Productivity Commission 1999) had even fewer inputs than our simulation, and did not produce outputs which could be validated against known cash out percentages. The solution came from re-examining our previously conducted focus group research studies to identify behaviours that might account for this discrepancy. Players had often talked about strategies to control their level of expenditure during play. One common approach is to cash out once credits have reached a specified level (usually a factor of the initial cash wagered) and then wager a portion of the cashed out credits again (i.e., using “found money or winnings rather than our of pocket money to finance play activity). Up to this point the simulation had not modeled this behaviour so it was modified to allow for cashing out at certain levels and reinvestment of specific amounts. With these modifications we were able to still have the inputs representing the behaviour of the specific segments and achieve a cash-out of approximately 70%.

The figure below illustrates differences in percent cash out with and without reinvestment of winnings. If a player initially puts $50.00 into the VLT machine, does not cash out during play, and then cashes out $20,00 at the end of their play session he or she will have spent $30,00 with a cash out of 40%. If this same player, playing with the same money, and losing the same $30.00, could have a 70% cash out rate if they cashed out and reinvested $50.00 sometime during the session. The cash out rate is therefore inflated by the amount of cashing out, and reinvestment during a session. However, in designing the simulation this behaviour had to be modeled and the appropriate assumptions made in order to be able to validate the simulation at the individual level.

**FIGURE 1 Illustration of Difference between Cash Out and Cash Back**



The final model had the inputs and outputs listed below in figure 2.

**FIGURE 2 VLT Simulation Model Inputs and Outputs**

| Model Inputs | Model Outputs |
|---|---|
| Game Characteristics<br>Number of unique winning events<br>Probability of events<br>Payout for each event<br>Payout factor related to bet level<br>Play Characteristics<br>Credits played each spin<br>Credit value<br>Initial credits put into machine<br>Credits put in when run out<br>Max number of spins per session<br>Max total credits can bet<br>Credit cash out after % (will cash out after % of max spins reached)<br>Cash out trigger level<br>% initial credits in OR<br>% of total credits in<br>Strategy – reinvest or stop play when reach trigger level<br>Distribution of average lengths of play for segment<br>Plays per minute as a function of average length of play<br>Number of simulation sessions | Payout % (e.g., 95.04%)<br>Cash out %<br>Cash back %<br>Average spins taken<br>Credits in per session<br>Credits out per session<br>Cash out of pocket<br>Credits reinvested<br>Cost per session (losses)<br>Cost per spin<br>Percent sessions won and lost |

**Projecting to Provincial Totals**

The simulation was run using the median values for inputs and the results projected to the Provincial level to determine whether the simulation was performing in a representative manner. The numbers generated corresponded very well to the figures reported in the 1997-1998 annual report and, thus, suggest the simulation is fairly typical of what happens when real people play. When the projected provincial totals of the simulation for total cash in, total cash out and cash out percentage, are compared to those reported, the estimates are within a few percentage points of the actual provincial figures. Specifically, the simulation and survey results predict a provincial cash in of $393,120,862 compared to the actual of $404,746,203, a difference of 2.9%. The simulation predicts a cash out of $282,673,485, compared to $283,750,702, a difference of less than one percent, and a cash out percentage of 71.9% compared to 70.3% for the Province, off by 1.6 percentage points. The simulation therefore predicts expenditure by these regular players of $110,447,377. According to the VL Player Survey, these players account for 96% of the VL revenue, or $115,200,000, a difference of 4.1% from the simulation estimate. Thus, based on the data inputs from the survey, the simulation produces estimates that accurately reflect the true provincial figures. This underscores the viability of the approach and the potential value of the simulation in modeling player behaviours.

**SIMULATION RESULTS**

Each of the three segments was profiled using the simulation. However, space limitation prohibits us from presenting the results for all three. Instead, Tim, a typical player base on median values for all inputs, is profiled.

The typical player, named Tim, sits down to play. He has $100.00 in his pocket to play VL games. He selects a reel game with 8 lines on which to bet with each credit valued at a nickel. He initially puts in $10.00 to start playing, and will put the remaining $90.00 in $5.00 at a time if he loses. At this point, he intends to stop if he spends all of his $100.00, or he has played for an hour. If, after 15 minutes of play, he more than doubles his initial "investment," he cashes out the "win" and then re-invests it in additional play. He occasionally uses the "stop button" available on the terminal, but, for the most part, he lets the "spinning" come to a stop. At this rate, he plays an average of eight spins a minute while he is playing. However, during this time, he also talks to his friend, visits the washroom, orders and consumes some food and drink, and generally loses concentration. As a result, his actual spin rate over the one-hour is five spins per minute.

This particular player likes to cover all lines with at least a single credit bet, and then covers selected other lines, for a total of fourteen credits wagered each spin. In the simulation, Tim plays 20,000 sessions. He comes out ahead in 24% of the sessions. On average, 71.7% of the money he puts into the machine he takes out as cash slips. The average amount he puts into the machine during the session is $104.94. This is more money than he brought with him to play, but he has reinvested his winnings and this is added to the out-of-pocket amount that he had brought with him and put into the machine. He has cashed out, on average, $75.23 (72% of the cash in) leaving $29.70 (28.3%) in the machine, on average, after each play session. The prize payout rate was 95.04%, exactly the same as the average prize payout in 1997/98 for all players.

As Tim, the typical player, wins, he can use the machine's money (i.e., winnings) as part of his cash in, thus, leaving some of his $100.00 in his pocket. The simulation shows that of the $104.94 he cashed in, only $54.56 came out of Tim's pocket, and the remaining $50.38 represents the winnings he re-invested in play. If Tim ignores the cash in from his winnings, his cash back percentage from his "out-of-pocket" expenses is 46% (i.e., he put in $54.56 and lost $29.70 per session. The remaining $24.85 represents the cash he got out of the machine at the end of the session).

Cash Out, Cash Back and the percent of winning sessions were calculated for the three segments and are presented below in Table three.

**FIGURE 3 Cash-out, Cash-back and Percent Winning Sessions by Player Segment**

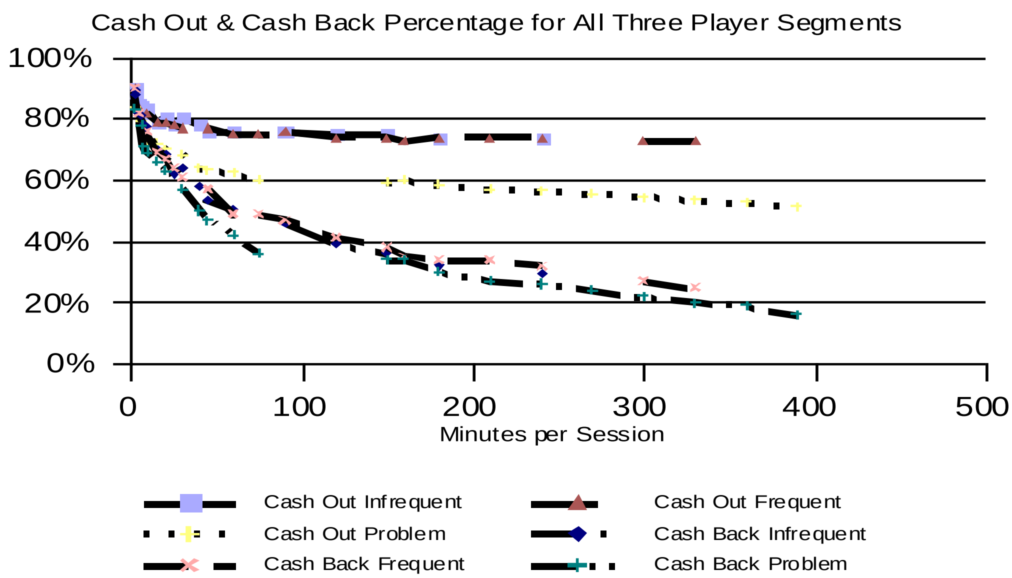


**TABLE 3 Cash Out, Cash Back and Percent Winning Sessions by Regular VL Player Segments**

| | All Players | Infrequent Players | Frequent Players | Problem |
|---|---|---|---|---|
| Cash Out | 72% | 77% | 75% | 60% |
| Cash Back | 51% | 54% | 46% | 37% |
| % Wins | 24% | 28% | 25% | 19% |

What was learned from these simulations is that several play behaviors exhibited by the three segments have little to no effect on cash out or cash back. Regardless of how much they initially put into the machines, the amount they bet each spin/play and the amounts subsequently spent while playing the games, the cash out and cash back percentages do not differ over the same number of spins. This is because the payback percentage (95.04%) is the same for all players, regardless of the amount spent. If the cash out rules used by the three segments were the same then the main determinant of cash out and cash back is the length of time (number of spins) they play.

Table four presents the reinvestment estimates for each segment derived by the simulation. It can be seen that the reinvestment constitutes a large percentage of the credits wagered by players, accounting for approximately 50% for the two non-problem segments, and 36.9% for the Problem Player Segment. Although the total amount reinvested is higher for the Problem Players, the fact that they are less likely to reinvest their winnings early on in a session when the chances of being up are greatest, leads them to a lower percentage of reinvestment as a percent of total credits wagered.

**TABLE 4 VL Player Segment Reinvestment Behaviour**

| | Infrequent Players | Frequent Players | Problem |
|---|---|---|---|
| Total Credits Wagered Per Session | $70.80 | $107.27 | $190.87 |
| Total Cash in from out of pocket | $35.16 | $50.27 | $120.00 |
| Total Credits reinvested | $35.64 | $57.00 | $70.47 |
| % of total credits wagered that are reinvested | 50.3% | 53.1% | 36.9% |

## Conclusions

The purpose of this paper is to illustrate the application of computer simulation in developing an understanding of consumption behaviour. The Monte Carlo simulation provided considerable insight into the play behaviour of the VL Player segments. Given the estimates of Player behaviour supplied by the players in a survey, and the known figures supplied by the gaming industry, the simulation was constrained enough that the final model had to incorporate specific behaviours (i.e., reinvestment) in order to validate the model against known parameters. The simulation then provided outputs that estimated the extent to which these behaviours occurred.

Once validated, the model was able to determine the impact of segment player behaviour on key outcomes that could not be measured by regulators, in part because the machines at this time cannot track play on a per session basis. The resulting estimates provided useful information as to the impact of VL play on specified VL player segments that could be useful in formulating public policy in order to help understand the effects of problem VL play, and eventually help control it.

There are many industries with customers whose consumption activities are undertaken on a continuous or long-term basis that can have more severe consequences financially and personally if the consumer has misconceptions of the relationship between their behavior and its outcome. The service providers in many of these industries are able to track consumption behaviours through billing records, or by other tracking mechanisms such as that found in the gaming industry with VLT machines. In these circumstances, where there are gaps in understanding of consumption behaviour due to the inability of consumers to provide reasonable estimates of the extent of their behaviours, simulations can provide reliable estimates that can be useful to both marketers and policy makers.

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