WHO IS DUE BACK? PART III:

A CLOSER LOOK AT THEORETICAL WIN

By Dr. A. K. Singh, Andrew Cardno and Bart A. Lewin

In Parts I and II of this "Who is Due Back?" series, we looked at clustering techniques and how they can be applied to predict when a customer is "due" to return to gamble at a casino property. The clustering techniques were designed to de-average the customers and create different groups of behaviors.

After receiving feedback on Andrew Cardno's CEM Blog (www.CasinoEnterpriseManagement.com/blog) posts on theoretical win and measurements, we have decided that before finishing the due-back series, we need to take a look at the reliability of the measurements themselves. This is a critical addition to our now four-part series, because measurement of the outcome is fundamental to understanding every aspect of the marketing program.

It seems that casino marketers have theoretical win in their DNA. This is because they are likely, as are marketers in many industries, to have the recency, frequency and monetary value (RFM) gene. The due-back series analysis uses these metrics to build sophisticated models.

Metrics in Play

Calculating recency and frequency elements is fairly intuitive. A recency score for an individual, for instance, could be calculated by looking at the number of days that have passed since his or her last gambling trip. A frequency score for an individual could be calculated by looking at how many trips he or she made to the establishment during a particular time period. Though the definitions of a "trip," the length of the period, and whether or not averages or other factors should be used are subject to debate, in the end, there will be a fairly straightforward and accurate measurement.

Establishing a metric for measuring the monetary value of a customer for gambling activity, however, is not as clear cut. In other industries, this is more or less an accounting exercise—add the revenue gained from purchases, less the cost. Theoretical win—the most common monetary value measurement for individual players

in the gaming industry—has been used for a long time and is an excellent notion, but it is impacted by subjective elements and measurement errors that significantly degrade its effectiveness. Understanding the biases that this measurement contains is a critical component of optimizing due-back programs.

First, let's look at the definition of theoretical win. Generally, theoretical win is defined as the amount of money the casino expects to win from a game or an individual in the long run. Sometimes theoretical win is calculated from the point of view of the customer—i.e., how much the customer is expected to lose. In this general definition, there is a distinction between the theoretical win for a game and for a player.

Now let's examine the definitions more closely. For a table game player, theoretical win (monetary value of the player to the casino) may be defined by the following equation:

Theo Win = Avg Bet x Hours Played x Decisions Per Hour x House Advantage[1]

We will cover this calculation in more depth in a follow-up article, as the treatment of table games has significant additional issues. For now, let's address the theoretical win of slot games, which may be defined by the following equation:

Theo Win = Coin-in x Hold Percentage

For these equations, coin-in is the total amount bet and hold percentage is the proportion of the amount bet that will be kept by the machine during the game cycle. This is a function of the slot's pay table. The number of possible game outcomes and the random number generator algorithm determine the game cycle—in some games this could be as many as 4 million games.

For most slot machines, because the outcome of each game is independent of other games, the theoretical win is, in aggregate, very close to the actual win over time and over a large number of machines. It's much like flipping a fair coin.[2] The first three flips may all come out heads, but it you flip the coin 100 or more times, the outcomes will be very near split evenly between heads and tails. For a fair coin, if the pay table pays even money for every coin bet each time the player successfully calls the side, the hold percentage is zero (the odds of winning or losing are 1:1). However, if the pay table was changed to pay 0.75 coins for each coin bet when successfully called, the hold percentage would then be 12.5 percent.

From the slot player's perspective, the definition gets more convoluted, defined by the following equation:

$$\text{Theo Win} = \sum_{\text{for } i=1 \text{ to } n} (\text{Coin-in} \times \text{Hold Percentage for the Device})_i$$

For this equation, i is an individual gaming session; n is the number of gaming sessions during a predefined period of time; coin-in is the total amount bet on a single slot machine during a gaming session; and hold percentage is as defined above.

For example, if a player plays $100 on Slot Machine A, which has a hold percentage of 25 percent, and then later that day plays $500 on Slot Machine B, which has a hold percentage of 10 percent, the player's theoretical win for that day is (100 x .25) + (500 x .10), or $75.

If we look closely at the components for theoretical win from the slot player's perspective—the monetary value measurement commonly used by marketing departments to segment players for offers—we can see that it is primarily a function of coin-in played and the hold percentage of the slot machine.

> It seems that casino marketers have theoretical win in their DNA. This is because they are likely, as are marketers in many industries, to have the recency, frequency and monetary value (RFM) gene.

Let's examine coin-in. This is a measurement of the amount of money wagered on the slot machine. It seems that with modern casino management systems (CMS), this would be a straightforward calculation. However, because slot promotions such as free play (which awards a player credits to bet on a slot machine) and other game promotions are so popular today, even this most basic measurement poses some interesting questions[3]:

- Does the money given in free play count as coin-in?
- Does giving players additional play time increase your coin-in?
- Does money wagered on side bets or on extraneous jackpots that offer large payouts count as coin-in for calculating a player's theoretical win?
- If the hotel offers a prize (e.g., "press here for a free dinner"), does that affect a player's theoretical win?

In each of these cases, it would seem that the coin-in component of theoretical win, and therefore the theoretical win figure itself, is inflated. Not only will the theoretical win of lucky players (in terms of the free play bonus they have won) be inflated by the credits won, but for many players, it will also be inflated by "the hold percentage multiplier effect." The effect works like this: Many players gamble under the belief that if they are holding money in excess of their buy-in (the cash they initially put into a slot machine), then they are "playing on the house's money," and therefore, they bet this money more freely than they would when betting with their own buy-in amount. (This is in contrast to players who consider winnings "their own money" once they control the money or credits and therefore manage all bets the same way.) For the players under the hold percentage multiplier effect, the "house's money" not only applies to the bonuses they have been given but may also apply to the amounts won while playing those bonuses.

The effects of this can be dramatic on earnings and may be calculated as such:

Hold Percentage Multiplier Effect = Bonus Amount / Hold Percentage

For this equation, we assume that all cashable winnings from betting the bonus amount are played. To develop this formula, we could assume a free play offer is $10, the house advantage is .05, and every player plays until the entire bankroll (starting with the $10 free play) is lost:

Total Coin-in = 10 + 10 x .95 + 10 x .95^2 + … = a + ar + ar^2 + … (a = 10, r = .95)

This is a geometric series with sum = a/(1-r) = 10/(1-.95) = 10/.05 = 200.

For example, if a player is given a $10 bonus that is played on a slot with a 5 percent hold percentage, if that player is subject to

the hold percentage multiplier effect, he or she may play as much as $10 / .05 = $200, increasing the theoretical win by the full $10, rather than by $0.50 (the theoretical win on the bonus amount only). There are many implicit assumptions that make the outcome here very unlikely to occur, but it does point to an important effect of bonuses on coin-in measurements. *[Note: We must be very cautious with this calculation, as the multiplier is subject to the same drawbacks as those described for the hold percentage component discussed below.]*

To really solve the coin-in problem, perhaps we should introduce multiple measures, such as these that follow, and weight them in the theoretical win calculation:

- Bonus credit wager
- Player's cash wager
- Side bet wager

Adding weights to the previous equation would change it to:

Player Theoretical Win = $\sum_{\text{for } i\ 1\text{-}n}$ *((Coin-in x Coin-In Category Weighting Factor) x (Hold Percentage)*$_i$

These inflationary effects are important, especially if a marketing department is using theoretical win bands to as a cost basis for an offer.

Now let's investigate the hold percentage component. There are three major coin-in anomalies that we need to be aware of. First, the hold percentage for a slot machine varies greatly depending on how a machine is played and the amount bet on a particular game. A CMS will typically allow for a few blended hold percentages to be entered for a particular slot. Of course, the blended percentage does not reflect how an individual machine or player has played. Nonetheless, this number is used to calculate an individual player's total theoretical win for a period.

Second, the hold percentages used to by the CMS may not take into account progressive jackpots, side bets or bonuses available to the player, and sometimes these awards vary based on time on device and the player's behavior.

And third, hold percentages are calculated based on the random number generator used by the slot machine's cycle—i.e., a machine is expected to hold X percent of all wagers made for Y number of games played. With today's sophisticated slots, Y could be a seven-figure number. This is important because, in some cases, if the average daily theoretical win for a short period (e.g., a two-day trip) is being used to make marketing decisions—which is a very common metric—the player has likely been subject to a miniscule percentage of the cycle for which the hold percentage is based, allowing the possibility of the calculation being highly skewed.

Once we can correct for the coin-in anomalies discussed above, the problems outlined may not have significant effects on the quality of our calculations.

The anomalies described above regarding the components of the player's theoretical win calculation must be discussed in the context of what is to be done with the data. The two primary marketing department uses are customer segmentation and offer generation. One effective approach to providing an analytical framework for these anomalies is to categorize the player by his or her theoretical hold behavior. This results in groups of players based on their behavior. For example, build a category of players who always play max bet and optimize their chances of a jackpot. These players are probably not as profitable as players who play in less optimum ways, so we can adjust the profitability modeling to account for the different behaviors and market to this group of customers in an appropriate way.

Cardno has been known to say that there is no true measurement of a customer in gaming. With the advent of downloadable games, it is more important than ever to decipher this multidimensional measurement maze. Downloadable games have the potential to adjust the gaming floor dramatically, and as we make these adjustments, our view of what a gaming space is will change dramatically, from a slow-to-change gaming floor to a dynamic environment where the floor may be adapted to better meet the demands of the customers every day.

The Dutch author, philosopher and scholar Desiderius Erasmus once said that "in the land of the blind, a one-eyed man is king." As such, reliance on theoretical win has produced quite acceptable results so far. But if you have not already done so, it may be time to open the other eye and add some depth to the analysis that surrounds this key business measurement. The methods of doing so are many, but the fundamental idea is the same.

Our next article will take this measurement to the next step and demonstrate one method of how we can apply theoretical win to building measurements of when a customer is "due back."

1 Jim Kilby, Jim Fox, Anthony F. Lucas (2004). *Casino Operations Management*. John Wiley and Sons.

2 http://academic.kellogg.edu/mckayg/buad112/web/pres/newunit_4.htm, Kellog Business Statistics Unit 4.

3 www.casinoenterprisemanagement.com/blog/deciphering-measurement-mystery, Andrew Cardno, CEM Blog.

DR. A. K. **SINGH**

Dr. A. K. Singh has taught statistics, mathematics and operations research courses at New Mexico Tech, Socorro, N.M., and statistics and mathematics courses at University of Nevada, Las Vegas. He has more than 75 publications in theoretical and applied statistics and can be reached at aksingh@unlv.nevada.edu.

ANDREW **CARDNO**

Andrew Cardno has more than 16 years of experience in business analytics, ranging from modeling health care drive times to casino gaming floor analytics. He often presents on the future of analytics across the world and has spent the last seven years living in the United States and working with corporations around the world. He can be reached at andrewcardno@yahoo.com.

BART A. **LEWIN**

Bart A. Lewin has more than 25 years of experience in the engineering and information technology field, holding serveral technical and executive technical management positions. He is currently a technical and management consultant. He can be reached at balewin@mac.com.