

## The House Always Wins In The Long Run

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Robert J. Marks:

Welcome to mind matters news. I'm your winning host. Robert J. Marks. I teach a graduate course and probability and stochastic processes. There I teach the stupidity of casino gambling. In statistics, there's a theorem called the law of large numbers. It teaches you can't win in the long run at casino games. Period. The law of large numbers is a mathematical truth. It's a law as serious as the law of gravity. It's why casinos always get rich and the gambler always gets poor. There is a chance that you will win the lottery or win a million dollars jackpot in the casino, but there's also a chance you will get hit by falling space debris while juggling. In games like R letter craps there are no winning streaks. When played fairly, there is no chance of winning in the long run. It's a mathematical law. I tell people it's better if you give your money to me and I'll decide whether or not to give it back, you have a better chance of walking away with money in your pocket.

Robert J. Marks:

Our guest to talk about this today is Sal Cordova. Sal is an interesting guy. He has degrees in mathematics, electrical engineering, computer science. He has a master's degree in applied physics from Johns Hopkins university. And he's done a lot of graduate studies, a lot of graduate work in biology at the national institutes of health. And the reason we have Sal here is because he has made money card counting, as part of his career and that's going to be an interesting thing to talk about because he knows about gambling and knows about these law of large numbers. So welcome Sal.

Sal Cordova:

Oh, thank you for having me on.

Robert J. Marks:

It's a pleasure to have you. Now, you are from the Philippines, right?

Sal Cordova:

Yes.

Robert J. Marks:

Okay. And you have a Spanish name. Why are the Spanish in the Philippines?

Sal Cordova:

They were conquered by the Spanish.

Robert J. Marks:

Yeah.

Sal Cordova:

And they just got taken over. And so I ended up having a Spanish name because the Spanish culture invaded that Asian island. So that's just kind of the story behind it. I do get funny looks when people don't know what I look like. And then they see me. It's like, oh, I was expecting to see someone Hispanic, not someone that looks Asian.

Robert J. Marks:

Okay.

Sal Cordova:

And so usually if you do see people that have Asian features, but a Spanish name, like mine, Salva Antonio Cordova, he's probably Filipino.

Robert J. Marks:

Now, wait, you only have three names. I thought in Spain, you had four names.

Sal Cordova:

Oh my, well, I just gave you my legal name. My full birth name was Anghel Salvador Tonio Cordova.

Robert J. Marks:

Okay.

Sal Cordova:

I'm trying to pronounce it like someone from Latin America. I can't imitate their accent perfectly.

Robert J. Marks:

Okay. Well, great. As I mentioned, casinos always win. One of the things that you know about, which I want to talk about is the history of gambling. In the mid 20th century, there were two geniuses from, I think they were both from Bell Labs and...

Sal Cordova:

It's Bill's MIT.

Robert J. Marks:

Shannon was with Bell Labs and he did a lot of work at MIT. So Thorpe was with MIT

Sal Cordova:

MIT. Yes.

Robert J. Marks:

Yeah. So it was Claude, Shannon and Thorpe. And one of the things they did is they were one of the first body worn computers into a casino and they tried to gamble it. Tell us about that.

Sal Cordova:

That's kind of a famous team because of who they were. Claude Shannon obviously was the one who authored Shannon's theory of information and that through him, they coined the word bit. And so information theory and the internet and the modern information age owes a lot to Claude Shannon. And Edward Oakley Thorpe, probably very successful hedge fund manager. He should have won the Nobel prize in economics because he independently arrived at the black ULS equation for options pricing.

Robert J. Marks:

Really.

Sal Cordova:

So instead of being an academic, what he quietly used his knowledge. He became a very successful hedge fund manager, which is the casino of the stock market. So these are basically two guys that were...

Robert J. Marks:

I've never heard of that, but okay. It's the casino.

Sal Cordova:

He wrote...Thorpe wrote the book, Beat the Dealer, which is how to beat the casinos, but he also wrote the book, Beat the Market.

Robert J. Marks:

Okay.

Sal Cordova:

And he actually did beat the market. So he applied gambling theory in two venues, one in brick and mortar casinos, and one in the stock market, which is the giant casino.

Robert J. Marks:

You shared a paper with me, a favorable strategy for 21. It was published in 1961. It was published in the proceedings of the national academy of sciences, which is pretty prestigious. And it was sponsored by Claude Janet.

Sal Cordova:

Claude Janet.

Robert J. Marks:

So they were good buddies. So do you know what happened when they wore the computer into the casino?

Sal Cordova:

They brought their wives with them and the wives were kind of in on this too. And they were going to hit the casinos and run up some winnings, but the computer broke down. And this is in the era before they had really developed VLSI. They did have 1961 technology to be doing some of what they were

attempting to do. Certainly if they had anything transistor based, you know that the memory capacity couldn't have been that big.

Robert J. Marks:

Yeah.

Sal Cordova:

So they did attempt to use a little bit of physics prediction to help them estimate the odds and therefore beat roulette. But they were unsuccessful basically because of a technical failure, but it was still the theory of blackjack that Thorpe especially was able to break. Thorpe was the one who was the pioneer blackjack, figuring out how to beat it. And he spent a year. That was his research. So that's kind of an interesting research project to publish on how beat the game. But he was a math professor at Massachusetts Institute of Technology. And I don't know how he got his department chair to approve that project, but I guess...

Robert J. Marks:

Well, when you're in mathematics, especially pure mathematics, you don't expect a lot of external funding because nobody cares what you do. You want to be an applied math if you're, if you're going to get funding of that sort.

Sal Cordova:

Oh, that's the other thing, is some mathematicians are actually pretty offended if you find some practical use for what they found.

Robert J. Marks:

Yeah, exactly. So that clearly was not Thorpe. He was really looking into doing something with his thought. Yeah. I had heard that they were looking at roulette. I don't know where I read this, but apparently if there was any sort of slanting or imbalancing of the roulette wheel, there was redundancy in the winnings and they were trying to figure that out. Now, they were trying to cheat. They were trying to game the system, I guess maybe that's where gaming the game came from. Is there any history of casino cheats? Is there a good way to go in and cheat in casinos at all?

Sal Cordova:

It's probably not a good idea today because you could get prosecuted for it and...

Robert J. Marks:

Serious. Well, yeah, I guess you could.

Sal Cordova:

There are laws in Las Vegas. If you actually now bring computers in and use it to beat the games, you could be prosecuted for that. I mean, stuff that is done now is only called cheating by law, but in my book you're not really going against the rules of how to actually play your hands or anything. So I've really not looked much into the techniques of cheating because I just didn't want to get prosecuted.

Robert J. Marks:

Oh, I see.

Sal Cordova:

But there has been, I'm trying to think of any examples where I knew anyone. I can't think off the top of my hand.

Robert J. Marks:

Well, I read a book called Race Horse. There was a story about a black in Southern United States that got sent to prison for terrible things. And he was raised, his mother was a prostitute and he was raised in this terrible house. But one of the things he used to do is gamble a lot. He maintained that he could throw a dice in order to get a high probability of a seven. He literally knew how to throw the dice, but it had to do with something like sliding the dice.

Sal Cordova:

Oh yeah.

Robert J. Marks:

And you can't do that in Las Vegas anymore, right?

Sal Cordova:

Not anymore. They actually passed the law. So just kind of like how gyroscopes work, you have a lot of angular momentum. It resists certain motions. And so what they would do these dice sliders, they'd throw the dice.

Robert J. Marks:

They call them dice sliders?

Sal Cordova:

Right. So like when you throw football, you try to throw it with spin because that helps stabilize it. And so they were throwing the dice with a lot of spin and then sliding it across the table. So it never tumbled. So whatever you set the dice, you just have like a seven on top, basically with your two dice. If you could slide the dice, there was no randomizing. And so Las Vegas realized these people were so good at it, that they were changing the odds. First, they passed laws and then they started to pass rules within the casino.

Robert J. Marks:

Now those were not casino laws. These were like state laws or something or city laws.

Sal Cordova:

So it was the Las Vegas laws. Then you couldn't dice slide. But then on top of that, the casinos began to put felt so that the dice wouldn't slide. And then they put these little pyramids on the ends and then they forced you to throw the dice in a certain fashion. So it...

Robert J. Marks:

Has to bounce against the back wall, at least in the movies.

Sal Cordova:

Yes. It has to bounce. It has to fly. You can't slide it.

Robert J. Marks:

Yeah.

Sal Cordova:

So they made it and then they started to put arresting wires so that if you tried to slide it across from where you are, it would hit the arresting wire. So they forced you to basically lob it. And then they made it.

Robert J. Marks:

So it's like jumping a hurdle.

Sal Cordova:

Yes. Oh. And then they made very sharp corners on the dice. They got some good physics to count as a countermeasure, but those must have been the glory days of being a crafts player. Because if you're really well practiced at this, you only needed to tilt the odds. Even you didn't even need to do it all the time. If you could just get like maybe a few percent in your favor, you could, you could beat the game.

Robert J. Marks:

Isn't that fascinating?

Sal Cordova:

But now I do recall some instances of cheating where it was prosecuted. It's when the dealer had colluded with the players. So the dealer. Yes. So how the dealer could collude with the players and there's two famous cases. I had to go back into this.

Robert J. Marks:

Playing what game?

Sal Cordova:

Things like blackjack or backer at. So if the dealer reveals the card, what they call the whole card, it's the card that the players aren't supposed to see.

Robert J. Marks:

Yes.

Sal Cordova:

So the player will make playing decisions based on if he could make a playing decision based on knowledge he's not supposed to have, has a huge advantage. So in blackjack, the dealer has what they

call a whole card in saying, okay, this is the card you can't see. And after you've finalized your decision as a player, then he's going to reveal it. And then you find out whether you're going to win or lose.

Robert J. Marks:

Oh. And probably he didn't reveal it actually reveal it. He probably gave him signs like a third base coach in baseball touching the bureau or something.

Sal Cordova:

Well actually he could subtly reveal it with his hands, he could bend the card a little bit so the player could actually peek and see it.

Robert J. Marks:

Okay.

Sal Cordova:

And in one case, it was really funny. The casino surveillance noticed that the dealer was dealing out the exact same set of cards each time he had used the false shuffle. So somewhere...

Robert J. Marks:

Okay. Tell me about the false shuffle. What's a false shuffle?

Sal Cordova:

A false shuffle is where you're you look like you had actually shuffled the cards, but you didn't. I don't know how, how that is physically accomplished. You have to have good hands. It's kind magicians are able to do that. And there's a technique where you can make it look like you shuffled the cards, but you didn't. And so he was dealing out the same set of cards each time, and then they were realizing, why are the players so good at predicting what the next card's going to be? So all they had to do is the dealer would deal out one set of cards and the players would somehow take note of what the cards were. I don't know how they did that. And then the dealer would do a false shuffle and deal out the exact same sequence the next, the next time. And when that's done, the player has huge advantage.

Sal Cordova:

So the casino bosses began to be suspicious why this particular player was winning so well. Like he knew what the next card was going to be. And so they have casino surveillance and they used video cameras and they realized, oh wow, this is how it was being done. And the FBI came in and they prosecuted the guys.

Robert J. Marks:

Really.

Sal Cordova:

So those are the two big instances I know. And this is kind of interest to me because it starts to deal with issues of probability and kind of my areas of interest. What's the chances that you could deal the same decor cards, the same way each time. And this relates to things in some of our interest in biology and stuff. And so I was just fascinated.

Robert J. Marks:

So if I know Vegas, they had to come up with some sort of rule where the dealer doesn't shuffle or something like that. Is that true today? How are the the decks shuffled for blackjack? Does the dealer shuffle them?

Sal Cordova:

It depends on the casino. And there's some things where it would shuffle the deck and then he had put it in something called a shoe.

Robert J. Marks:

Yes.

Sal Cordova:

And it's dealt out there. And so they have these automatic shuffler and then they have these things called continuous shuffler where after the dealer deals it out, he puts it back in the machine and it shuffles it with their, with the cards in the deck. So there, there are all sorts of devices that they can use to shuffle, or it can be hand shuffled. The preferred method, I think, would be machine shuffling because it's faster. And it can randomize the cards to the standards that the casino would want. I see. Because there are some people that are just savant, they'll actually memorize the sequence. And if they have a good understanding of the shuffling techniques they can start to in interleave it in their own brain. And then they're able to predict.

Robert J. Marks:

Do you ever watch the movie Rainman with Dustin Hoffman and...

Sal Cordova:

I actually never saw that one. Yeah.

Robert J. Marks:

Well he's a savant. And he goes in and they're playing 21 and he keeps on saying hit or skip or something like that. So he knows what's going on.

Sal Cordova:

So those people that can do that are called shuffle trackers.

Robert J. Marks:

Shuffle trackers. And there's a whole nomenclature for casino gamblers.

Sal Cordova:

Oh, yes. There's shuffle trackers. There are they're ACE trackers or card counters. And sometimes you would have teams. Yeah. There are all, there are all these techniques. So you mentioned the law of large numbers and the casino always wins yeah. With the law of large numbers. So these players that are able to beat the game legally, we would call them advantage players. They actually turn the tables, figuratively speaking, and use the law of large numbers in their favor.



Robert J. Marks:

So tell me about advantage players. I would imagine a card counter would be an advantage player.

Sal Cordova:

Advantage players.

Robert J. Marks:

Yeah.

Sal Cordova:

So there's kind of a terminology. It's a little bit derogatory. The advantage players are usually your math guys.

Robert J. Marks:

So listen up all your nerds, right? Yeah. Looks like they're...

Sal Cordova:

Yeah. They know the odds. They have this proper skills to execute it in the casino and they're able to turn the statistical advantage in their favor because they use their minds and ordinary gamblers, they call pappies because these guys just kind of plop in their seat and just. Yeah. Get sawed. Okay. Get sawed down and beaten down by the casino. They're like sheep being sent to the slaughter and we call them ploppies. So you're either a player or a ploppie.

Robert J. Marks:

I see. I want to be a player.

Sal Cordova:

You want to be a player?

Robert J. Marks:

Yeah.

Sal Cordova:

And so the advantage player uses his math skills. First of all, to decide is the game beatable at all. If it's not, then he shouldn't play it. Now there's an interesting anecdote to that. The worst week in Las Vegas history was when the American physical society had their annual meeting in Las Vegas and the casino.

Robert J. Marks:

This is a gathering of nerds, right?

Sal Cordova:

Right. And the casinos were like, yeah, this is going to be great. We're going to have the American physical society here. After that week, Vegas lost so much money. They said, we'll never allow them to host another conference here.

Robert J. Marks:

Really?

Sal Cordova:

Yes. And it wasn't ironically because all these physicists physicists were great gamblers. I mean, in the sense that they were, they just didn't play. They knew that it wasn't worth it. And so Las Vegas didn't make any money off of them. And so Las Vegas was opening all their hotels and stuff.

Robert J. Marks:

Giving them free food and comps and free.

Sal Cordova:

Or whatever. And they said that had been the worst week in history. They said, we'll never invite the American physical society there again. So the first thing of an advantage player is to realize when he can't beat the game, you don't play it.

Robert J. Marks:

I see. So they would not participate in something like roulette or craps.

Sal Cordova:

There are ways to even beat that game, but you have to have certain event. There are ways to beat it, but it's not within the rules of the game. There's another angle to this. Yeah. The casinos often give, like in the stores, you get coupons. They also give coupons to gamble. So sometimes they'll give you free bets as an incentive, or you can find you...

Robert J. Marks:

Or they they give you free chips.

Sal Cordova:

Free chips, or you buy these coupon books for like \$14. And or if you happen to get a hold of a bunch of them, and you might be able to get a whole bunch of coupons, there have been teams of advantage players that have pulled their coupons and they took the casinos for millions. Or if you work out deals.

Robert J. Marks:

They pull, oh, so a bunch of people came in, they all got their coupons and gave it to some advantage player, right? Is that right?

Sal Cordova:

Coupons is one way where they figured out the casinos were loose with their coupons, something like that. There's an angle. The ones where these unbeatable games, where you can actually beat them is the casino worked out a deal that they didn't realize was way too advantage. So let's give an example. So in craps, the advantage, I think of the house on what they call the pass line bet is like 1.4% against the player.

Robert J. Marks:

Okay. Now that's the difference between winning and losing? Is that what you mean? What's the 1.4%. I don't get that. That's a very small number.

Sal Cordova:

It's like over the long haul. Let's say you're betting \$10 every bet.

Robert J. Marks:

Okay.

Sal Cordova:

And say you played a bazillion hand quote unquote.

Robert J. Marks:

On average, you'll lose 1.

Sal Cordova:

1.4%.

Robert J. Marks:

1.4%.

Sal Cordova:

That's the expected value.

Robert J. Marks:

Yeah.

Sal Cordova:

So over a mil, let's say you were playing dice and you're betting \$10 at a time, but your total action over like say a million hands quote, unquote hands would be \$10 million. Well, you take 1.4% of that. That's how much you're expected to lose. Now there's variance. So you have the expected value and the variance around that expected value. So you may not exactly be at 1.4%, but the law of large numbers will tell you that your expected value over time would be 1.4% of your total action.

Robert J. Marks:

Sort of interesting.

Sal Cordova:

Yeah.

Robert J. Marks:

Let me ask you, as a mathematician in something like craps, for example, is there anything such as a winning streak?

Sal Cordova:

Yes. But since the trials are independent, what we call be newly independent trials, you can't use the streak to predict whether you're going to win or lose and see these are the illusionary patterns that can fool people. They think they're on a roll in the next. Therefore, what they call the dice table being hot. You want to be there because the next you're just going to start winning. And then you have the people that look at for opposite patterns. It's like, well, this table's just been losing and losing. It's got to win or. Just all sorts of things.

Robert J. Marks:

And I've heard the casinos take advantage of this. One of the things they do over roulette tables is they put a list of the history of the winnings, right?

Sal Cordova:

Right.

Robert J. Marks:

And they put like, and I don't know the numbers, I'm making them up. Black 32 red, 14 green, double zero, et cetera. And people look at this table and they think, oh my goodness, black is overdue over. We've had, we've had, we've had six greens in a row. So it has to come up black this time. But that has nothing to do with it. It's totally independent of the past, right?

Sal Cordova:

That's right. It's very hard to explain to some people that over time it may work sometimes and that's enough to make them feel that they've got a system and it just doesn't work. I did want to complete one thing.

Robert J. Marks:

Oh, go ahead.

Sal Cordova:

Because you did ask, how can you beat these unbeatable games? Let's say that in the craps, the past line advantage of the house against you is 1.4%. Well, if they're giving you a 20% rebate on, on your losses, you're going to kill the casino. And sometimes...

Robert J. Marks:

And these come from the cards and the comps, is that what you're saying or?

Sal Cordova:

Sometimes when they have what they call a whale.

Robert J. Marks:

Okay.

Sal Cordova:

Where that's a customer that has a lot of money. They want to give them a big incentive. And so sometimes they'll make a mistake.

Robert J. Marks:

Okay. That's another word for my glossary.

Sal Cordova:

A whale. Oh, yeah. We have all these terms, whales. And so sometimes the way they get these whales who actually are advantaged players, is that the player's just a really good con artist. He might have come in there and just acted like he's a total drunk and degenerate and just frivolous. It's a really good actor. And they're like, "Hey, we'll give you this 20% loss rebate. So when you have a really bad night, we'll give you 20% of all your losses back."

Robert J. Marks:

Really?

Sal Cordova:

Yeah.

Robert J. Marks:

And that's cumulative throughout the night.

Sal Cordova:

Yeah.

Robert J. Marks:

Oh my goodness. Okay.

Sal Cordova:

Okay. So now where does this come into play? The audience here can look at the history of someone named Don Johnson.

Robert J. Marks:

Don Johnson.

Sal Cordova:

Now there are a lot of people named Don Johnson with this.

Robert J. Marks:

Well, he was, he was in Miami vice wasn't he?

Sal Cordova:

Right. That was the actor. There's the Don Johnson who cleaned out Atlantic city. So just Google it, like in the last 10 years.

Robert J. Marks:

He cleaned out Atlantic city.

Sal Cordova:

Oh yeah, he did because he had this 20% loss rebate. And it was only a matter of time before his advantage started to assert itself. So the, what he did was he got a loss rebate from one casino. And then he told the other casinos, he said, look at the rebate that this guy is giving me. And so they started upping their loss rebates while he was on a losing streak. But he knew that in the end, all he needed to do. I think maybe he actually got lucky that at the start he was losing, but he had deep pockets. And so they started competing for his business because they thought he was a loser. So I guess no one bothered to analyze his playing skills, which were decent enough. That his blackjack was only playing at a loss of like half a percent.

Sal Cordova:

And so then he got that winning streak that was inevitable. He just needed to survive in the law of large numbers, eventually kicked in and he cleaned out some casinos. Their monthly revenue was negative just by that one player. So I invite the readers to look at that. So he actually, that's an example of an advantage player actually playing a game that was guaranteed to lose the way the style of blackjack played without card counting. He could have done this with craps or anything, but they're giving him generous loss rebates. And so even some of these online casinos in some of the early days where they had some of these kind of these casinos that were overseas or whatever, and they weren't very sophisticated, they were offering loss rebates. I know some players who just cleaned out those casinos because the loss rebates they realized were too generous.

Sal Cordova:

They may have figured out how to have multiple accounts or something so that they could really run it up, but they became millionaires within a year. So these are some of the skills of the advantage players in their repertoire is, it's not just the game. It's the marketing incentives and they find it a defect in it. So for the viewers there who want to try to beat the casinos, maybe not try to do something as hard as card counting, just look at those sort of marketing things. And then you mentioned the comps. So like if you play even an average game and not lose too much money, say it like the Venetian in Las Vegas, you could be put up in \$400 a night suites.

Robert J. Marks:

The Venetian, is that's one of the casinos?

Sal Cordova:

Yes. It's my favorite casino.

Robert J. Marks:

That's your favorite one. Okay.

Sal Cordova:

Yeah. It's real classy place. Nice and clean.

Robert J. Marks:

Have they ever come to you?

Sal Cordova:

Yeah, I was staying in \$400 a night hotel rooms for a week. And I'm just like, I think I probably only lost like \$20 on their, on some of their games. So there are other ways to be compensated than just the cash. There are other casinos around the land that are in really nice luxurious places. And if you're an advantage player, you could just get a very nice discount basically on your travels. So there are other ways to kind of gain the system, using marketing comps.

Sal Cordova:

So for the audience, I would recommend those. It takes a lot of skill and ability to actually beat it, like using card counting and some of these other techniques where you really have to be thinking and using your mind heavily, whereas using the marketing comps, you can kind of play an average game and you don't have to develop a lot of the skills. And certainly there's skills I didn't develop like shuffle tracking. Those guys are just, they're just on another level of ability. One guy he said yeah, every night he would take a deck of cards and just go through all of them. He'd wake up in the morning. He'd recite the sequence.

Robert J. Marks:

Oh my gosh.

Sal Cordova:

Yeah. These guys...

Robert J. Marks:

As I get older, I don't know if you've ever heard it, but the long term memory of a goldfish average is about three seconds. So I think that's about my long term memory. Yeah. I couldn't do it overnight. Well, Sal, this has been great. We've been talking to Sal Cordova about the algorithms of gambling and how to beat the game. We're going to be talking to Sal about some other things in subsequent podcasts. So stay tuned. Thank you, Sal. And until next time be of good cheer.

Announcer:

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