Uncovering Lottery Shenanigans

Skip Garibaldi

For centuries, the lottery has been an interesting subject for mathematics. The combination of enormous amounts of money, minuscule probabilities, and repeated game play naturally leads to subtle probability problems that have attracted the attention of well-known mathematicians such as Leonhard Euler [6], Herman Chernoff [4], and Persi Diaconis and Frederick Mosteller [3].

The amounts of money are indeed enormous, as Americans spend around \$80 billion each year on the lottery. That's more than twice Microsoft's worldwide revenue and is roughly what the United States spends annually on incarceration [1]. With that much money changing hands and with laws and the level of enthusiasm for enforcing those laws varying from state to state, it's not surprising that there are shenanigans going on.

What kinds of shenanigans, you ask?

- Inside jobs, like the drawings allegedly rigged by Eddie Tipton [2] or the 1980 Pennsylvania Lottery scandal dramatized in the movie *Lucky Numbers* [8].
- Exploiting a design flaw in a particular lottery game, as Mohan Srivastava did for the Ontario Lottery with their scratcher games Tic-Tac-Toe (2003) and SuperBingo (2007); see [14], [10].
- People buying lots of tickets on the rare occasions when the expected rate of return was positive, such as:
 - the Massachusetts Cash WinFall game that ran 2005–12 [5], [13].
 - Stefan Mandel buying all (or almost all) of the tickets in the Virginia Lottery in 1992 and others [12].
- Whatever Joan Ginther, the so-called “Luckiest Woman on Earth,” is up to, as described in [7], [9].

Those are all interesting stories, and I've provided references in case you want to learn more about any of them, but this talk is about a different kind of shenanigan. The shenanigan in this talk doesn't depend on the rules of any particular game. People are using the technique now in many states across the United States and have been for many years. In some places it is illegal, and everywhere it is practiced it diverts money from the poor and powerless. It has even been used by criminals to launder money.

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The story begins with an unusually perceptive reporter, Lawrence Mower, who looked at the list of prizes given out by the Florida Lottery and noticed that some individuals had claimed staggering numbers of large prizes. On the one hand, something fishy was going on. On the other hand, there is a positive probability that those individuals legitimately won that many prizes with only modest spending—that they were phenomenally lucky. (That was effectively the theory presented by the Florida Lottery secretary, who said, “That's what the lottery is all about. You can buy one ticket and you become a millionaire” [11].) Deciding between these two views is not as easy as you might guess, and the answer can depend on the details of the games played. For example, a pathological gambler who bets in the right way can indeed win many modestly large prizes while only losing their house.

To resolve the disagreement between these two views, Mower enlisted the help of three professors who set to work proving theorems and exploiting those theorems to make calculations. This talk will be about that work and the results of Mower's subsequent on-the-ground investigations. The success of this work has led to further investigations by numerous reporters across the country, which in turn have led to arrests, changes in state policy, and legal disputes.

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