A Scientific Coin Toss Experiment*

How a coin toss can come silver spoon up

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When flipping a fair, well-balanced coin, it is normally assumed that there is a 50% probability of it coming up heads and a 50% probability of it coming up tails. There is also the very small probability that the coin will land on its edge. What about even more unlikely tail-events? Have you heard of quantum physics and quantum probability? And have you heard of Schrödinger's cat?

In the quantum world, the strangest and most unexpected things can happen. Can such things also happen in the macroscopic world of everyday objects? If so, do we need to adjust our thinking around probability calculus? The probability for some very strange phenomena is very low indeed, but they can happen. Two professors recently met for lunch, one with a background in quantum physics and quantum probabilities and another one with a background in finance.

Key Words: Kolmogorovs probability, conditional probabilities.

Quantum Professor: What is the probability of getting heads up on a coin toss bet?

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Finance Professor: 50% on a fair coin, at least if we exclude the very small probability of it landing on the edge.

Quantum Professor: What about getting a silver spoon?

Finance Professor: What on earth are you talking about?

Quantum Professor: I am asking you what the probability is that a fair coin that is flipped will turn into a silver spoon? Have you heard of quantum probabilities? And what about Schrödinger's cat? And energy is related to matter, matter can change form, sometimes almost spontaneously. The reason you have not observed it is just that the probability is very low.

Finance Professor: You must have been studying way too much quantum physics. I am willing to bet my annual salary that if we are flipping a fair coin, it cannot turn into a silver spoon.

Quantum Professor: Well, why don't we make a coin toss bet? I pay you $20 if the coin shows up heads or tails, and you pay me your annual salary if the coin turns into a silver spoon. The probability that it will turn into a silver spoon is naturally extremely small, and I will therefore win much more if this extremely small probability manifests, but based on quantum physics, it can happen.

Finance Professor: Done!

Quantum Professor: I look at this as a scientific experiment, so we need to be very precise in defining the coin toss bet. As you know, quantum probabilities are on the finest scale and need very precise measurements.

Finance Professor: Okay, you write down the details.

Quantum Professor: I have written down the details for our scientific coin toss bet. There are 11 points that we must follow. Let me read them for you before you agree to this scientific coin toss bet:

1. The coin that is flipped is an uncirculated 2009 US Mint Silver Eagle 1 oz .999 Walking Liberty.
2. The weight of the coin is one troy ounce, that is 31.10 grams.
3. The weight of the coin will be measured on an atomic scale 5 minutes before the coin toss. The time will be measured with an atomic clock. If the weight of the coin diverges more than 1% from 31.10 grams, the bet will not be valid.
4. The person flipping the coin must carefully wash his hands with soap and let them dry before tossing the coin.
5. The clock used to measure the time frame must be a high-precision atomic clock.
6. The flipping of the coin will take place on Silver Street No. 3, on the first floor.
7. The coin toss will start at exactly 12 am at the above address.
8. The coin will be tossed by the Finance Professor for 10 minutes.
9. As close as possible to 12:10 am as measured by the atomic clock, you, the finance professor, will drop the coin on the top of the table that has been placed in the room on the first floor of Silver Street No. 3. The table is a normal fair table with a flat surface.
10. After the coin falls on the table, neither of us are allowed to touch it before the final scientific reading has taken place.
11. The exact time of the reading of the coin will be...

Finance Professor: (interrupting): I have heard enough, lets just do it. Where should I sign the coin toss bet contract?

Quantum Professor: Sign here at the bottom of the coin toss bet contract.

The two professors went to Silver Street No. 3. The finance professor tossed the one ounce silver dollar coin in his hands for 10 minutes. Then at 12:10 am, he let it drop to the top of the table in the room.

Finance Professor: See? It is tails. Ha. Ha. Ha. Your quantum probabilities failed. Give me $20 and stop reading so much quantum nonsense.

Quantum Professor: Please check the scientific coin toss bet you signed, in particular point 11.

Point 11: The exact time of the reading of the tossed coin will be exactly 1 week after we tossed the coin as measured by the atomic clock.

Finance Professor: Wait a week? What kind of nonsense is this?

Quantum Professor: Well, we had to have an exact time frame of when to measure the outcome of our experiment. If not, it would not be scientific. I set it at exactly one week. One week is just as good as 3 seconds or 5 minutes. And remember, according to point 10, neither of us are allowed to touch the coin. So, there is no need to worry.

Finance Professor: Fair enough. Let's come back in one week.

One week later, the two professors return to Silver Street No. 3. A beautiful woman opens the door. The two professors walk in.

Finance Professor: Where is the coin? We left a silver coin on this table one week ago.

Woman: : So, it was you that left the one ounce silver coin a week ago. A Quantum Professor called me last week and told me he would leave a one ounce silver coin on the table so I could make a silver spoon out of it. I was not here, so I left my door open. Here is the silver spoon. As per your request, I have engraved on it, "Probabilities are always conditional on the time frame".

Well, there was no need for quantum probabilities or Schrödinger's cat to explain how a coin toss can turn into a silver spoon. My point is simply that all probabilities are conditional on time. In addition, it is important to take into account the probability of asymmetric information [See Haug (2005)]. As described by Ballentine, in Kolmogorovs probability theory, the conditional probability is relegated to secondary status, while the mathematical fiction of absolute probability" is made primary. According to Ballentine (2001), there are several objections to taking Kolmogorovs axioms as the foundation of Probability Theory; it should rather be seen as a model of a more fundamental Probability Theory. Among other things, the secondary status of conditions in Kolmogorovs model can easily make us forget that in reality, any probability must actually be a conditional probability. I hope this article will make you think twice the next time someone talks about absolute probabilities. For every absolute probability, there is a hidden condition. As a minimum, all probabilities are conditional on time.

References

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