

Mega Millions

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Last Update: December 27, 2024

Initial Version: December 27, 2024

1 Introduction

Mega Millions® is a multi-state lottery game played in 45 states plus the District of Columbia and the U. S. Virgin Islands; a total of 47 jurisdictions. Section 2 of this short document describes the lottery rules and the probability of winning the jackpot. Section 3 describes the expected value of a \$2 Mega Millions ticket.

2 Probability of Winning the Jackpot

What are the odds of winning the Mega Millions jackpot?

It turns out that the odds of winning are 1 in 302,575,350 [1].

Ok, but why? Let's see...

1. In the Mega Millions game there are 70 white balls, numbered 1 to 70, in one drum. 5 balls are chosen from this drum in the drawing. So there are

$$\binom{70}{5} = 12,103,014$$

ways to choose the 5 white balls. This calculation ignores order, which doesn't matter in Mega Millions.

2. We also need to choose the Mega Ball. There are 25 Mega Balls, numbered 1 to 25, in a different drum. 1 ball is chosen from this drum in the drawing. So there are

$$\binom{25}{1} = 25$$

ways to choose the Mega Ball.

3. So the number of ways to choose 5 white balls and 1 Mega Ball in the Mega Millions game is

$$12,103,014 \times 25 = 302,575,350$$

4. Putting this all together we see that the probability of choosing the correct 5 white balls and the Mega Ball, call it $p(\text{winning})$, is

$$p(\text{winning}) = \frac{1}{302,575,350} \approx 3.30 \times 10^{-9}$$

Said another way, the odds of winning are 1 in 302,575,350.

3 Expected Value of a Mega Millions Ticket

First, this is what we know:

1. Advertised Jackpot: $\$1.15 \times 10^9$ as of 12/27/2024
2. Probability of Winning: $p(\text{winning}) = \frac{1}{302,575,350}$
3. Lump Sum Option: Typically 60% of the advertised jackpot, so take the Lump sum to be
$$\text{Lump sum} = (\$1.15 \times 10^9) \times 0.60 = \$690.00 \times 10^6$$
4. Taxes: Both Federal and potentially state taxes apply. Assume these numbers are
 - Federal tax rate: 37%
 - State tax rates vary but average around 5%
 - Combined tax rate: 42%

Then the Post-tax lump sum = $\$690.00 \times 10^6 \times (1.00 - 0.42) = \400.20×10^6

3.1 Adjusted Lump Sum per Winner

If the jackpot is split among n winners, each winner receives:

$$\text{Post-Tax Lump Sum Share} = \frac{\text{Post-Tax Lump Sum}}{n} = \frac{\$400.20 \times 10^6}{n}$$

For example:

- For one winner ($n = 1$), the Post-Tax Lump Sum is $\$400.20 \times 10^6$
- For two winners ($n = 2$), the Post-Tax Lump Sum is $\$200.10 \times 10^6$
- For three winners ($n = 3$), the Post-Tax Lump Sum is $\$133.40 \times 10^6$
- ...

3.2 Expected Number of Winners

The expected number of winners depends on T , the number of tickets sold and the odds of winning. That is, the expected number of winners is

$$\text{Expected Number of Winners} = T \times p(\text{winning}) = \frac{T}{302,575,350}$$

For example, suppose 500 million tickets are sold¹, so that $T = 500 \times 10^6$. Then

$$\text{Expected Number of Winners} = \frac{500 \times 10^6}{302,575,350} = 1.65$$

¹Apparently Mega Millions doesn't publish the total number of tickets sold for any given drawing.

3.3 Post-Tax Lump Sum per Winner

In our example there are 1.65 winners on average, so each winner receives:

$$\text{Post-Tax Lump Sum Share} = \frac{\$400.20 \times 10^6}{1.65} = \$242.50 \times 10^6$$

3.4 Expected Value (jackpot only) of a Mega Millions Ticket

The expected jackpot payout per ticket is Post-Tax Lump Sum Share \times Odds of Winning.

Substituting the values for Post-Tax Lump Sum Share and the Odds of Winning we get

$$\frac{\$242.50 \times 10^6}{302,575,350} \approx \$0.80$$

So given our assumptions the expected value of a Mega Millions lottery ticket is \$0.80.

3.5 Net Expected Value of a \$2 Mega Millions Ticket

Given our assumptions of 500×10^6 tickets sold, personal taxes of 42%, and a jackpot of $\$1.15 \times 10^9$, we see that the net expected value of a \$2 ticket is $\$0.80 - \$2 = -\$1.20$.

4 Conclusions

Assuming a $\$1.15 \times 10^9$ jackpot with 500×10^6 tickets sold and a 42% personal tax rate, the expected value of a Mega Millions ticket is approximately \$0.80. Subtracting the \$2 ticket cost, the net expected value of a ticket is approximately -1.20.

Acknowledgements

L^AT_EX Source

References

- [1] Mega Millions Group. Mega Millions. <https://www.megamillions.com/>, 2024. [Online; accessed 27-December-2024].