

Appreciating The Risk Of Ruin

by Nauzer J. Balsara



Traders focus on developing trading rules and systems that identify market entry and exit points. A factor that is often overlooked is the percentage of trading capital available that is risked on trades. STOCKS & COMMODITIES contributor and author Nauzer Balsara analyzes the risk of ruin by varying three parameters using a Monte Carlo simulation. The results can help you determine your chances of success.

A trader is said to be ruined if his or her available capital falls below the minimum required to trade.

The risk of ruin is a probability estimate ranging between zero and 1. A probability estimate of 0 suggests that ruin is impossible, whereas an estimate of 1 implies that ruin is assured. The risk of ruin is a function of:

- The probability of success
- The payoff ratio, or the ratio of the average win to the average loss on completed trades
- The fraction of capital exposed to trading.

In its most elementary form, the formula for computing the risk of ruin as defined by statistician William Feller makes two simplifying assumptions: that the payoff ratio is 1 and that the entire capital in the account is risked to trading. Under these assumptions, the risk of ruin (R) is defined as:

$$R = \frac{\left(\frac{q}{p}\right)^a - \left(\frac{q}{p}\right)^k}{\left(\frac{q}{p}\right)^a - 1}$$

where:

a = overall market capitalization

k = trader's capital exposed to trading

p = the probability of success

q = the complementary probability of failure

where:

$$q = (1-p)$$

Assuming the trader's opponent is personified by the market as a whole, a is a very large number compared with k , and hence the term

$$\left(\frac{q}{p}\right)^a$$

tends toward zero, reducing the probability of ruin to

$$\left(\frac{q}{p}\right)^k$$

Note that the risk of ruin in the above formula is directly proportional to the units of capital exposed to trading and inversely proportional to the probability of success. The lower the fraction of capital exposed to trading is, the lower the risk of ruin is. Conversely, the higher the probability of success is, the lower the risk of ruin is.

The formula above is silent regarding the payoff ratio, assuming that the average dollar win is exactly equal to the average dollar loss. When the average win does not equal the average loss, the risk of ruin calculations become more involved. In fact, when the average win is greater than twice the average loss, the differential equations associated with the risk of ruin calculations do not lend themselves to a precise or closed-form solution. Because of this mathematical difficulty, the next best alternative is to simulate the risk of ruin.

SIMULATING THE RISK OF RUIN

The risk of ruin is simulated as a function of three variables:

p = the probability of success

k = the percentage of capital exposed to trading

W = the payoff ratio

For the purposes of the simulation, the probability of success ranges from 0.05 to 0.90 in increments of 0.05. Similarly, the payoff ratio ranges from 1 to 10 in increments of 1. The simulation is based on the premise that a trader risks \$1 in each round of trading. This represents $(100/k)\%$ of the initial capital of \$ k . For the present study, the percentage of capital exposed to trading (k) is set at 100%, 50%, 25% and 10%, respectively.

A fraction between zero and 1 is selected at random by a random number generator. If the fraction lies between zero and $(1-p)$, with p being the probability of success, the trade is said to result in a loss of \$1. Alternatively, if the fraction is greater than $(1-p)$ but less than 1, then the trade is said to result in a win of \$ W , with W being the payoff ratio, which is added to the capital at the beginning of that round of trading.

Trading continues in a given round until such time as the entire capital accumulated at the start of that round is lost or the initial capital increases 100 times to $100k$, at which stage the risk of ruin is presumed to be negligible. Exiting a trade for either reason marks the end of that round. The simulation is repeated 100,000 times to arrive at the most likely estimate of the risk of ruin for a given set of parameters. The risk of ruin is defined by the fraction of times the available trading capital at the start of a round is lost over the course of 100,000 trials. To simplify the analysis, we will assume that there is no withdrawal of profits from the account.

SIGNIFICANCE OF SIMULATION RESULTS

The simulation results are presented in [Figures 1, 2, 3 and 4](#). As expected, the risk of ruin is directly proportional to the fraction of capital exposed to trading and inversely proportional to the probability of success and the payoff ratio. The risk of ruin is 1 for all payoff ratios less than or equal to 2, regardless of capital exposure, as long as the probability of success is less than or equal to 0.30 ([Figures 1, 2, 3 and 4](#)). The risk of ruin drops rapidly as either the probability of success or payoff ratio increases, the magnitude of the drop depending upon the fraction of capital at risk. The risk of ruin falls most rapidly to zero when only 10% of available capital is exposed ([Figure 4](#)).

As expected, the risk of ruin is directly proportional to the fraction of capital exposed to trading and inversely proportional to the probability of success and the payoff ratio.

For example, when the probability of success is 0.65 and the payoff ratio is 0.50, the risk of ruin is 1.00 regardless of capital exposure ([Figures 1, 2, 3 and 4](#)). When 100% of available capital is exposed to trading, the risk of ruin diminishes to a steady level of 0.349 when the payoff ratio increases to 5 ([Figure 1](#)). When 50% of capital is exposed to trading, the risk of ruin dwindles to a constant level of 0.125 when the payoff ratio increases to 4 ([Figure 2](#)). With only 25% of capital exposed to trading, the risk of ruin levels off at 0.016 ([Figure 3](#)) when the payoff ratio is 3. And finally, when only 10% of capital is exposed to trading, the risk of ruin is reduced to 0.002 when the payoff ratio is just 1 ([Figure 4](#)).

PROBABILITY OF SUCCESS

A low probability of success of 0.15 can lead to assured ruin notwithstanding an exceptionally high payoff ratio of 5 and an exposure fraction as low as 10% ([Figure 4](#)). Similarly, a low payoff ratio of 0.50 results in assured ruin even if the probability of success is as high as 0.65 and the exposure fraction is a

low 10% (Figure 4). What is needed is a reasonably high probability of success coupled with a payoff ratio greater than 1.

Figure 4 shows that the risk of ruin is 0.608 when the probability of success is 0.35, the payoff ratio is 2 and the capital exposed to trading is 10%. The risk of ruin drops dramatically to 0.033 when the probability of success increases to 0.45 (Figure 4)! Small wonder, then, that so much time and money is invested in enhancing the effectiveness of technical trading systems: the probability of success and the payoff ratio are variables that are exclusively trading-system dependent.

However, the capital exposed to trading is yet another critical factor influencing the risk of ruin that ought not to be overlooked. This is a money management consideration that is as important as, if not more important than, the system-dependent factors alluded to above. If the trader risks everything he or she has to a single trade (Figure 1) and the trade does not materialize as expected, there is a 40% probability of being ruined, notwithstanding an astronomical payoff ratio of 10 and a probability of success of 0.60! This should not be ignored by traders in their relentless quest for the ultimate trading system.

A trader can use the simulation results in one of two ways. The trader can assess the risk of ruin for a given exposure level. Alternatively, Figures 1, 2, 3 and 4 can be used to determine the exposure level that will translate into a prespecified risk of ruin. Assume that the probability of success is 0.55 and the payoff ratio is 2. Assume, furthermore, that the trader wishes to risk 50% of capital to open trades at any given time. Figure 2 shows that the associated risk of ruin is 0.289. Assume, then, that the trader is comfortable with a risk of ruin estimate not exceeding 0.10. By the trader working with the same probability of success and payoff ratio, Figure 3 implies that he or she should risk only 25% of available capital instead of the 50% contemplated earlier, giving the trader a more acceptable risk of ruin estimate of 0.082.

CONCLUDING REMARKS

The obsession with enhancing the performance measures of a technical trading system to the total exclusion of money management considerations, embodied in the fraction of capital exposed to trading, can lead to traders' ruin. Traders with superior trading systems may be tempted to discount this as a remote possibility. However, a trader who equates a remote possibility with a zero probability is unlikely to be prepared either financially or emotionally to deal with ruin should it occur.

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REFERENCES

Balsara, Nauzer J. [1992]. *Money Management Strategies for Futures Traders*, John Wiley & Sons.
Feller, William [1950]. *An Introduction to Probability Theory and Its Applications*, Volume I, John Wiley & Sons.

PROBABILITY OF RUIN TABLES										
AVAILABLE CAPITAL = \$1; CAPITAL RISKED = \$1 OR 100%										
	PROBABILITY OF SUCCESS			PAYOFF RATIO						
	0.50	0.75	1	2	3	4	5	6	8	10
0.05	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
0.10	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.978
0.15	1.000	1.000	1.000	1.000	1.000	1.000	0.999	0.979	0.923	0.894
0.20	1.000	1.000	1.000	1.000	1.000	0.990	0.926	0.886	0.844	0.822
0.25	1.000	1.000	1.000	1.000	0.990	0.887	0.834	0.804	0.775	0.761
0.30	1.000	1.000	1.000	1.000	0.881	0.794	0.756	0.736	0.715	0.705
0.35	1.000	1.000	1.000	0.951	0.778	0.713	0.687	0.671	0.659	0.653
0.40	1.000	1.000	1.000	0.825	0.691	0.647	0.621	0.611	0.602	0.599
0.45	1.000	1.000	1.000	0.714	0.615	0.579	0.565	0.558	0.551	0.550
0.50	1.000	1.000	0.989	0.618	0.541	0.518	0.508	0.505	0.499	0.498
0.55	1.000	1.000	0.819	0.534	0.478	0.463	0.453	0.453	0.453	0.453
0.60	1.000	0.857	0.667	0.457	0.419	0.406	0.402	0.402	0.400	0.400
0.65	1.000	0.648	0.537	0.388	0.363	0.356	0.349	0.349	0.349	0.347
0.70	0.798	0.493	0.430	0.322	0.306	0.300	0.300	0.300	0.300	0.300
0.75	0.557	0.366	0.335	0.266	0.252	0.252	0.252	0.252	0.249	0.249
0.80	0.375	0.263	0.251	0.205	0.201	0.201	0.198	0.198	0.198	0.198
0.85	0.242	0.181	0.175	0.153	0.151	0.151	0.150	0.150	0.150	0.150
0.90	0.135	0.111	0.110	0.101	0.101	0.101	0.101	0.101	0.100	0.100

FIGURE 1: This table illustrates your chances of ruin if you risk 100% of your capital on each trade. If your probability of success is 0.60 and your expected payoff ratio is 10 times, you still have a 40% chance of ruin.

PROBABILITY OF RUIN TABLES										
AVAILABLE CAPITAL = \$2; CAPITAL RISKED = \$1 or 50%										
	PROBABILITY OF SUCCESS			PAYOFF RATIO						
	0.50	0.75	1	2	3	4	5	6	8	10
0.05	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
0.10	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.962
0.15	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.966	0.850	0.798
0.20	1.000	1.000	1.000	1.000	1.000	0.990	0.858	0.781	0.714	0.680
0.25	1.000	1.000	1.000	1.000	0.991	0.789	0.695	0.645	0.601	0.581
0.30	1.000	1.000	1.000	1.000	0.773	0.631	0.572	0.541	0.511	0.500
0.35	1.000	1.000	1.000	0.906	0.606	0.511	0.470	0.451	0.433	0.426
0.40	1.000	1.000	1.000	0.678	0.479	0.416	0.392	0.377	0.366	0.363
0.45	1.000	1.000	1.000	0.506	0.378	0.337	0.321	0.312	0.305	0.302
0.50	1.000	1.000	0.990	0.382	0.295	0.269	0.260	0.253	0.251	0.251
0.55	1.000	1.000	0.672	0.289	0.229	0.212	0.208	0.205	0.203	0.203
0.60	1.000	0.743	0.443	0.208	0.174	0.166	0.161	0.161	0.161	0.159
0.65	1.000	0.434	0.289	0.151	0.130	0.125	0.125	0.125	0.123	0.122
0.70	0.645	0.250	0.185	0.106	0.093	0.090	0.090	0.090	0.090	0.088
0.75	0.321	0.137	0.112	0.071	0.064	0.063	0.063	0.063	0.063	0.063
0.80	0.146	0.071	0.063	0.044	0.042	0.040	0.040	0.040	0.040	0.039
0.85	0.061	0.033	0.032	0.023	0.023	0.023	0.023	0.023	0.023	0.022
0.90	0.019	0.012	0.012	0.010	0.010	0.010	0.010	0.010	0.010	0.010

FIGURE 2: This table illustrates your chances of ruin if you risk 50% of your capital on each trade. If your expected payoff ratio is twice and your probability of success is 0.60, you have a 20.8% chance of ruin.

PROBABILITY OF RUIN TABLES										
AVAILABLE CAPITAL = \$4; CAPITAL RISKED = \$1 or 25%										
	PROBABILITY OF SUCCESS									
	PAYOFF RATIO									
	0.50	0.75	1	2	3	4	5	6	8	10
0.05	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
0.10	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.926
0.15	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.936	0.727	0.638
0.20	1.000	1.000	1.000	1.000	1.000	0.990	0.736	0.612	0.503	0.459
0.25	1.000	1.000	1.000	1.000	0.991	0.620	0.487	0.422	0.358	0.337
0.30	1.000	1.000	1.000	1.000	0.599	0.399	0.327	0.290	0.260	0.250
0.35	1.000	1.000	1.000	0.820	0.366	0.264	0.222	0.201	0.187	0.180
0.40	1.000	1.000	1.000	0.458	0.229	0.174	0.152	0.142	0.133	0.130
0.45	1.000	1.000	1.000	0.259	0.142	0.111	0.102	0.097	0.092	0.092
0.50	1.000	1.000	0.990	0.147	0.086	0.072	0.067	0.064	0.063	0.062
0.55	1.000	1.000	0.447	0.082	0.052	0.045	0.044	0.043	0.042	0.041
0.60	1.000	0.564	0.195	0.043	0.030	0.027	0.027	0.025	0.025	0.025
0.65	1.000	0.199	0.083	0.023	0.016	0.016	0.015	0.015	0.015	0.015
0.70	0.431	0.067	0.036	0.011	0.009	0.008	0.008	0.008	0.008	0.008
0.75	0.112	0.022	0.013	0.005	0.004	0.004	0.004	0.004	0.004	0.004
0.80	0.024	0.005	0.004	0.002	0.002	0.002	0.002	0.002	0.002	0.001
0.85	0.004	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
0.90	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

FIGURE 3: This table illustrates your chances of ruin if you risk 25% of your capital on each trade. If your expected payoff ratio is 4 times and the probability of success is 0.60, you then have a 2.7% chance of ruin.

PROBABILITY OF RUIN TABLES										
AVAILABLE CAPITAL = \$10; CAPITAL RISKED = \$1 or 10%										
	PROBABILITY OF SUCCESS									
	PAYOFF RATIO									
	0.50	0.75	1	2	3	4	5	6	8	10
0.05	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
0.10	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.822
0.15	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.849	0.449	0.325
0.20	1.000	1.000	1.000	1.000	1.000	0.990	0.467	0.297	0.178	0.144
0.25	1.000	1.000	1.000	1.000	0.990	0.303	0.162	0.113	0.078	0.067
0.30	1.000	1.000	1.000	1.000	0.277	0.102	0.060	0.045	0.034	0.031
0.35	1.000	1.000	1.000	0.608	0.082	0.036	0.023	0.018	0.015	0.014
0.40	1.000	1.000	1.000	0.143	0.025	0.013	0.008	0.008	0.007	0.006
0.45	1.000	1.000	1.000	0.033	0.008	0.004	0.003	0.003	0.002	0.002
0.50	1.000	1.000	0.990	0.008	0.002	0.001	0.001	0.001	0.001	0.001
0.55	1.000	1.000	0.132	0.002	0.001	0.001	0.000	0.000	0.000	0.000
0.60	1.000	0.248	0.017	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.65	1.000	0.021	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.70	0.128	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.75	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.80	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.85	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.90	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

FIGURE 4: This table illustrates your chances of ruin if you risk just 10% of your capital on each trade. If your probability of success is 0.45 and your expected payoff ratio is only twice, your chance of ruin drops to 3.3.