Diversification or Diworsification: The Kelly Criterion

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Agenda

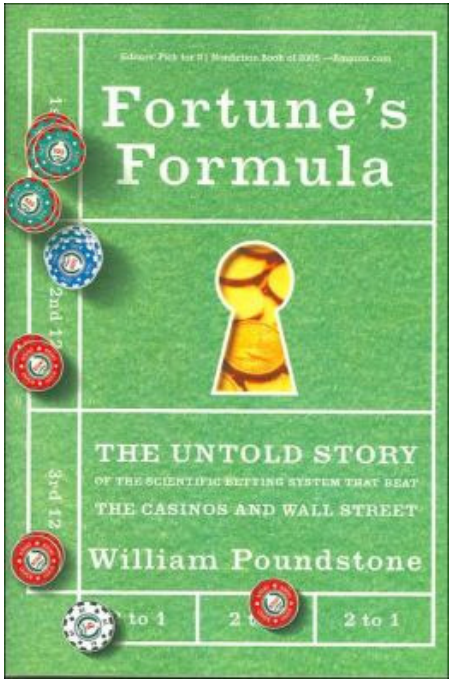
1. Introduction to John Kelly, Jr.
2. The Kelly Criterion
3. Modeling Portfolio Concentration
4. Superinvestor Portfolios
5. Q & A

Who is John Larry Kelly, Jr.?

Among financial professionals there is little objective reasoning applied to position sizing and optimizing portfolio diversification.

John Larry Kelly, Jr.
1923 - 1965

- AT&T Bell Labs scientist
- Publisher of "Information Theory and Gambling"
- Created the Kelly Criterion to determine optimal bets in a sequence of positive expected value opportunities to maximize rates of compounded growth



The Kelly criterion is for people who want optimize compounding capital

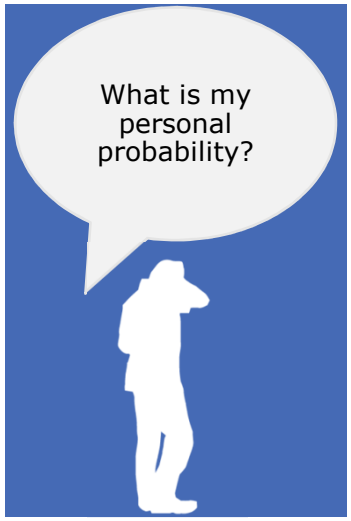
$$\text{Kelly \%} = W - [(1-W)/R]$$

- W (win) = Number of Positive Outcome Trades / Total Trades
- R (gain / loss ratio) = Total Positive Trade Amounts / Total Negative Trade Amounts

When faced with a choice of wagers or investments, choose the one with the highest geometric mean of outcomes.

- *Fortune's Formula* by William Poundstone

The million dollar question



What is the probability of a positive outcome and the gain-to-loss ratio in my portfolio?

Biased by:

- Overconfidence
- Association
- Self-interest
- Self-serving
- Other known / unknown

Is your personal data set large enough to be statistically significant?

$$\text{Kelly \%} = W - [(1-W)/R]$$

Can we solve this problem backward by looking at all possibilities?

Matrix 1: Modeling Kelly Position Size as a Function of W and R

W (Winning Probability): # of trades with positive results / # of historical trades

W \ R	1	1.05	1.1	1.15	1.2	1.25	1.3	1.35	1.4	1.45	1.5	1.55	1.6	1.65	1.7	1.75	1.8	1.85	1.9	1.95	2
0.8	60%	61%	62%	63%	63%	64%	65%	65%	66%	66%	67%	67%	68%	68%	68%	69%	69%	69%	69%	70%	70%
0.79	58%	59%	60%	61%	62%	62%	63%	63%	64%	65%	65%	65%	66%	66%	67%	67%	67%	68%	68%	68%	69%
0.78	56%	57%	58%	59%	60%	60%	61%	62%	62%	63%	63%	64%	64%	65%	65%	65%	66%	66%	66%	67%	67%
0.77	54%	55%	56%	57%	58%	59%	59%	60%	61%	61%	62%	62%	63%	63%	63%	64%	64%	65%	65%	65%	66%
0.76	52%	53%	54%	55%	56%	57%	58%	58%	59%	59%	60%	61%	61%	61%	62%	62%	63%	63%	63%	64%	64%
0.75	50%	51%	52%	53%	54%	55%	56%	56%	57%	58%	58%	59%	59%	60%	60%	61%	61%	61%	62%	62%	63%
0.74	48%	49%	50%	51%	52%	53%	54%	55%	55%	56%	57%	57%	58%	58%	59%	59%	60%	60%	60%	61%	61%
0.73	46%	47%	48%	50%	51%	51%	52%	53%	54%	54%	55%	56%	56%	57%	57%	58%	58%	58%	59%	59%	60%
0.72	44%	45%	47%	48%	49%	50%	50%	51%	52%	53%	53%	54%	55%	55%	56%	56%	56%	57%	57%	58%	58%
0.71	42%	43%	45%	46%	47%	48%	49%	50%	50%	51%	52%	52%	53%	53%	54%	54%	55%	55%	56%	56%	57%
0.7	40%	41%	43%	44%	45%	46%	47%	48%	49%	49%	50%	51%	51%	52%	52%	53%	53%	54%	54%	55%	55%
0.69	38%	39%	41%	42%	43%	44%	45%	46%	47%	48%	48%	49%	50%	50%	51%	51%	52%	52%	53%	53%	54%
0.68	36%	38%	39%	40%	41%	42%	43%	44%	45%	46%	47%	47%	48%	49%	49%	50%	50%	51%	51%	52%	52%
0.67	34%	36%	37%	38%	40%	41%	42%	43%	43%	44%	45%	46%	46%	47%	48%	48%	49%	49%	50%	50%	51%
0.66	32%	34%	35%	36%	38%	39%	40%	41%	42%	43%	43%	44%	45%	45%	46%	47%	47%	48%	48%	49%	49%
0.65	30%	32%	33%	35%	36%	37%	38%	39%	40%	41%	42%	42%	43%	44%	44%	45%	46%	46%	47%	47%	48%
0.64	28%	30%	31%	33%	34%	35%	36%	37%	38%	39%	40%	41%	42%	42%	43%	43%	44%	45%	45%	46%	46%
0.63	26%	28%	29%	31%	32%	33%	35%	36%	37%	37%	38%	39%	40%	41%	41%	42%	42%	43%	44%	44%	45%
0.62	24%	26%	27%	29%	30%	32%	33%	34%	35%	36%	37%	37%	38%	39%	40%	40%	41%	41%	42%	43%	43%
0.61	22%	24%	26%	27%	29%	30%	31%	32%	33%	34%	35%	36%	37%	37%	38%	39%	39%	40%	40%	41%	42%
0.6	20%	22%	24%	25%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	36%	37%	38%	38%	39%	39%	40%
0.59	18%	20%	22%	23%	25%	26%	27%	29%	30%	31%	32%	33%	33%	34%	35%	36%	36%	37%	37%	38%	39%
0.58	16%	18%	20%	21%	23%	24%	26%	27%	28%	29%	30%	31%	32%	33%	33%	34%	35%	35%	36%	36%	37%
0.57	14%	16%	18%	20%	21%	23%	24%	25%	26%	27%	28%	29%	30%	31%	32%	32%	33%	34%	34%	35%	36%
0.56	12%	14%	16%	18%	19%	21%	22%	23%	25%	26%	27%	28%	29%	29%	30%	31%	32%	32%	33%	33%	34%
0.55	10%	12%	14%	16%	18%	19%	20%	22%	23%	24%	25%	26%	27%	28%	29%	29%	30%	31%	31%	32%	33%
0.54	8%	10%	12%	14%	16%	17%	19%	20%	21%	22%	23%	24%	25%	26%	27%	28%	28%	29%	30%	30%	31%
0.53	6%	8%	10%	12%	14%	15%	17%	18%	19%	21%	22%	23%	24%	25%	25%	26%	27%	28%	28%	29%	30%
0.52	4%	6%	8%	10%	12%	14%	15%	16%	18%	19%	20%	21%	22%	23%	24%	25%	25%	26%	27%	27%	28%
0.51	2%	4%	6%	8%	10%	12%	13%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%	25%	26%	27%
0.5	0%	2%	5%	7%	8%	10%	12%	13%	14%	16%	17%	18%	19%	20%	21%	21%	22%	23%	24%	24%	25%

R (Ratio of Gains to Losses): Gain of Positive Trades / Loss of Negative Trades

If we explore the Kelly Criterion for all combinations, what is the potential allocation range?

Kelly % = W – [(1-W)/R]

What does the Kelly Criterion suggest for optimal diversification?

Matrix 2: Kelly Optimal Number of Portfolio Positions as a Function of W and R

W: 55% - 65%	R*: 1x - 4x

W (Winning Probability): # of trades with positive results / # of historical trades

0.65	3.33	3.16	3.01	2.89	2.79	2.70	2.63	2.56	2.50	2.45	2.40
0.64	3.57	3.37	3.20	3.06	2.94	2.84	2.75	2.68	2.61	2.55	2.50
0.63	3.85	3.60	3.41	3.24	3.11	2.99	2.90	2.81	2.73	2.67	2.61
0.62	4.17	3.87	3.64	3.45	3.30	3.16	3.05	2.95	2.87	2.79	2.73
0.61	4.55	4.19	3.91	3.69	3.51	3.36	3.23	3.11	3.02	2.93	2.86
0.6	5.00	4.57	4.23	3.97	3.75	3.57	3.42	3.29	3.18	3.09	3.00
0.59	5.56	5.01	4.60	4.28	4.03	3.82	3.64	3.49	3.37	3.25	3.16
0.58	6.25	5.56	5.05	4.66	4.35	4.10	3.89	3.72	3.57	3.44	3.33
0.57	7.14	6.23	5.58	5.10	4.72	4.42	4.18	3.98	3.80	3.66	3.53
0.56	8.33	7.09	6.25	5.64	5.17	4.81	4.51	4.27	4.07	3.90	3.75
0.55	10.00	8.24	7.10	6.30	5.71	5.26	4.91	4.62	4.38	4.17	4.00
	1	**1.05**	**1.1**	**1.15**	**1.2**	**1.25**	**1.3**	**1.35**	**1.4**	**1.45**	**1.5**

R (Ratio of Gains to Losses): Gain of Positive Trades / Loss of Negative Trades

Given these parameters, the optimal allocation ranges from 10% to 56% of bankroll.
Maximizing geometric compounding occurs within 2 and 10 portfolio positions.

*Average gain for positive outcome: 20 to 40%. Average loss in negative outcome: 10 to 20%.

Limitations of Kelly

- **Requires a long-term (infinite) time horizon**
- **Leverage introduces danger because capital can be called**
- **Over allocation guarantees ruin over an infinite time series**

"One day he heard about a race with only one horse in it, so he bet the rent money. Halfway around the track, the horse jumped over the fence and ran away.

Invariably things can get worse than people expect."

-The Most Important Thing
by Howard Marks

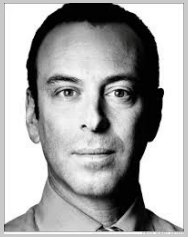
Who might be applying the Kelly Criterion today?

Baupost: Seth Klarman

- 93% of portfolio in 10 positions
- 14% in Micron Technology (MU)
- 7% in Cheniere Energy Inc. (LNG)

Hayman: Kyle Bass

- 6 positions
- 46% in General Motors (GM)
- 21% in Nationstar Mortgage (NSM)



ESL Investments: Eddie Lampert

- 4 positions
- 55% in Sears Holdings (SHLD)
- 24% in AutoNation (AN)

Pabrai Funds: Mohnish Pabrai

- 7 positions
- 24% in Horsehead (ZINC)
- 22% in General Motors (GM)

Fairfax: Prem Watsa

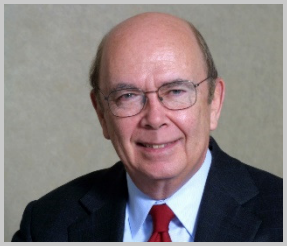
- 98% of portfolio in 10 positions
- 35% in Resolute Forest (RFP)
- 31% in BlackBerry (BBRY)

Pershing Square: Bill Ackman

- 7 positions
- 40% in Allergan (AGN)
- 20% in Can. Pacific Railway (CP)

Fairholme: Bruce Berkowitz

- 8 positions
- 22% in Bank of America (BAC)
- 13% in Sears Holdings (SHLD)



WL Ross & Co: Wilbur Ross

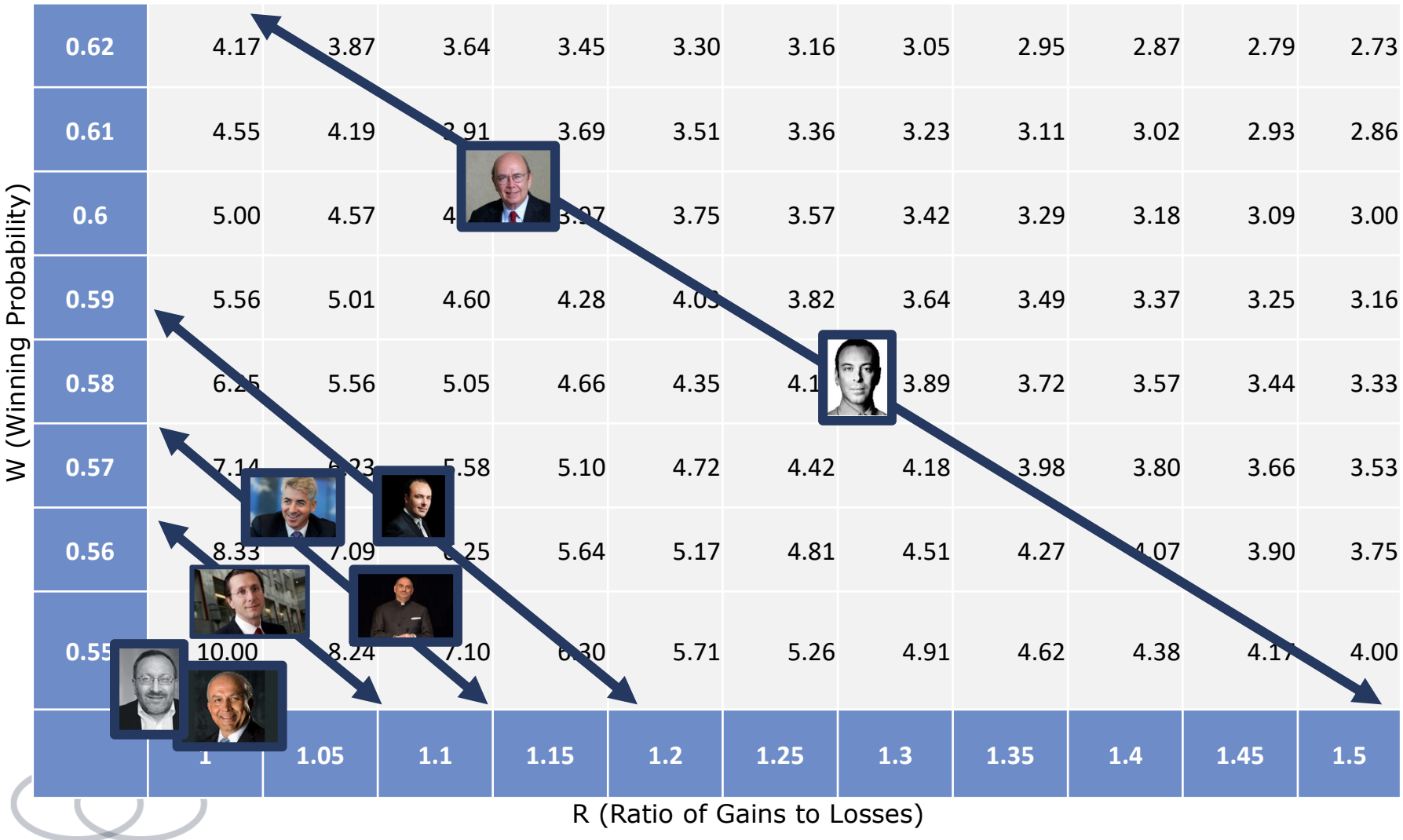
- 4 positions
- 54% in Navigator Holdings (NVGS)
- 17% in EXCO Resources (XCO)

Based on equity holdings disclosed in 13F-HR filings with the SEC and data from The Manual of Ideas, December 2014. Excludes cash, leverage, certain non-U.S. holdings, and non-equity securities.

Kelly % = W – [(1-W)/R]

How many positions are in your portfolio?

Matrix 2 Revisited: Incorporating Superinvestor Portfolio Positions



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Questions and answers

Q & A