

# **Are money line odds in UFC matches calibrated? Evidence from events in 2019-2020.**

Dr. Stephen Stanhope  
Chicago, IL  
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[stephen.stanhope@gmail.com](mailto:stephen.stanhope@gmail.com)

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**Abstract:** Whether money line odds from bookmakers are calibrated to future outcomes and underlying betting markets are efficient are fundamental and related questions. In this paper, I examine Ultimate Fighting Championship (UFC) events from 2019 to 2020 and evaluate whether given odds for match win, win method, and winning round outcomes are calibrated. My evaluation consists of a) qualitative and quantitative Hosmer-Lemeshow analyses, and b) quantitative likelihood ratio tests derived from logistic and multinomial models of match outcomes. I find that although money line odds for win wagers are calibrated for outcomes, those for win method and winning round are not.

## Data acquisition and processing:

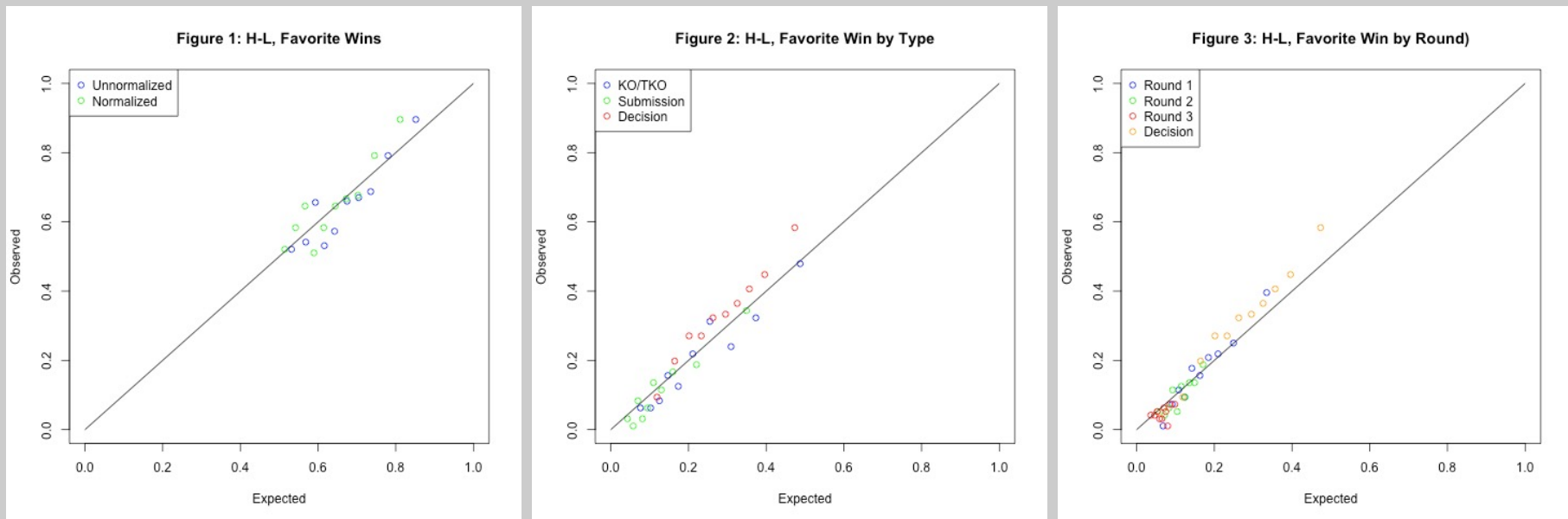
- Final bookmaker odds and outcomes for 961 UFC matches (28 events), Jan. 01 2019 – Dec. 31 2020 (bestfightodds.com, ufcstats.com)
- Match data: Winner (favorite / underdog), round of fight end (1<sup>st</sup>-3<sup>rd</sup>, by decision), method by which fight ends (KO / TKO, Submission, Decision)
- Propositions: Favorite wins, Favorite / Underdog wins by round; Favorite / Underdog wins by method.
- Odds-implied probabilities for propositions determined by averaging across bookmakers and performing basic normalization (Cortis 2015, Strumbelj 2013)

Fight #	Fighter	Win	Method	RD	Moneyline odds						
					Win	TKO	SUB	DEC	RD 1	RD 2	RD 3
2-190119	Gillespie	1	KO	2	-505.74	200.86	214.09	212.26	191.07	372.16	838.7
2-190119	Medeiros	0	KO	2	374.67	822.93	1241.25	943.28	1270.53	1563.29	2299.77
3-190119	Benavidez	1	DEC	3	-234.65	604.17	557.83	-117.29	627.83	825.65	1436.69
3-190119	Ortiz	0	DEC	3	189.10	839.51	1537.36	300.73	1284.61	1658.97	2348.46

Fight #	Win	Method	RD	Probabilities							
					Win	TKO	SUB	DEC	RD 1	RD 2	RD 3
2-190119	1	KO	2	<b>Favorite</b>	0.7985	0.2733	0.2618	0.2633	0.2777	0.1712	0.0861
				<b>Underdog</b>	0.2014	0.0783	0.0538	0.0692	0.0552	0.0454	0.0315
3-190119	1	DEC	3	<b>Favorite</b>	0.6696	0.1140	0.1220	0.4335	0.1044	0.0821	0.0494
				<b>Underdog</b>	0.3303	0.0843	0.0483	0.1976	0.0563	0.0443	0.0318

## Qualitative analysis (Hosmer-Lemeshow):

- Focus on propositions in which the favorite wins.
- Group matches by odds-implied probabilities, plot average odds-implied probability vs proportion of matches in which outcome occurred.
- The favorite winning by decision is under-estimated by odds-implied probabilities, in both analyses of round of match end and method of match end.



**Figures 1-3: Hosmer-Lemeshow plots of predicted vs observed match outcomes**

For possible match outcomes (favorite wins, favorite win by type, favorite win by round), by deciles of odds-implied probabilities average odds-implied probabilities are compared to the proportion of matches in which the outcome occurred. Calibration is indicated by points lying on the identity line. Although for most outcomes, odds-implied probabilities appear to be well calibrated, the favorite winning by decision appears to occur systematically more often than predicted – that is, odds-implied probabilities for that event appear to be miscalibrated.

## Quantitative analysis:

- Propositions in which favorite wins

- Hosmer-Lemeshow
- Logistic regression / Likelihood ratio test

$$H_0: \beta_0 = 0, \beta_1 = 1; \Pr(Y_n = 1) = \text{logit}(\beta_0 + \beta_1 q_n), q_n = \text{logit}^{-1}(p_n).$$

- Joint sets of propositions (favorite + underdog by win method, round)
  - Multinomial regression / Likelihood ratio test

$$H_0: \underline{\beta}_0 = 0, \underline{\beta} = I; \Pr(\underline{Y}_n = k) = \text{mlogit}(\underline{\beta}_0 + \underline{\beta} \underline{q}_n)_k, \underline{q}_n = \text{mlogit}^{-1}(\underline{p}_n)$$

Wager (Favorite)	H-L Test		Likelihood Ratio Test (LR-, MR-LRT)	
	Test Statistic	P-Value	LRT Statistic	P-Value
Favorite Wins	11.8985	0.1558	1.4966	0.4731
Favorite Wins, KO/TKO	10.0543	0.2612	2.5168	0.2841
Favorite Wins, Submission	10.4026	0.2379	3.4011	0.1826
Favorite Wins, Decision	14.9032	0.0611 *	11.7804	0.0028 **
Favorite Wins, Round 1	9.2463	0.3219	4.8187	0.0899 *
Favorite Wins, Round 2	6.4371	0.5984	1.3191	0.5171
Favorite Wins, Round 3	11.2537	0.1877	8.4729	0.0145 **
Joint Model, Win Method	NA	NA	52.6725	0.0064 **
Joint Model, Win by Round	NA	NA	80.5792	0.0174 **

**Table 1: Formal tests of model calibration**

Results from formal comparisons of odds-implied probabilities to outcomes marginally (H-L Test and LR-LRT, rows 1-7) and jointly (MR-LRT, rows 8-9). Marginally, wins by decision appear to be miscalibrated by either measure, with the LR-LRT indicating further miscalibration for favorites winning in rounds 1 and 3. Joint outcome analysis further confirms these results, showing miscalibration for odds-implied probabilities of either win by method or win by round, both of which include win by decision as a potential outcome.