

The Wisdom of Markets

Raymond D. Sauer
Clemson University

BB&T & Clemson Economics Summer Camp, July 2004

The Wisdom of Markets

Theme

Speculative markets are extraordinarily useful to society

Useful information is dispersed throughout the economy

Markets aggregate & thereby create new information

"Event markets" – betting on things like elections, horse races, and athletic contests - illustrate this process in action

The Wisdom of Markets

Outline

1. James Surowiecki's book, and why it's important
2. Theory: markets for contingent claims
3. Evidence from event markets

The Wisdom of Crowds

New book (spring 2004) by James Surowiecki

Extended illustration of the finding that groups of people tend to "know more" than isolated experts

Why?

1. Crowds aggregate information
2. Uninformed guesses will be randomly distributed
3. Canvassing "the crowd" picks up information overlooked by experts

The Wisdom of Crowds (2)

Examples from Suroweicki

1. Galton's ox

Thought surveying fair-goers estimates of the ox's weight would illustrate the folly of voting – wrong!

2. Jelly bean counts

The median guess is closer than the best guess

Finding is replicated in many prediction experiments

3. The Challenger disaster (Jan. 1986)

3 potential corporate culprits:

Lockheed: managed ground support

Martin Marietta: manufactured the fuel tank

Morton Thiokol: built the solid-fuel booster rocket

Stock market: instantly fingered Morton Thiokol

Presidential Hearing, six months later: Richard Feynman's drops Thiokol's O-ring in ice water

The Wisdom of Crowds (3)

Why It's Important

Criticism of psychology of speculative markets is ancient

Charles MacKay, poet, wrote *Extraordinary Delusions & the Madness of Crowds*, in 1841

A "classic" on account of the subject matter, not its treatment

Great Stock Market Crash (1929), "mini-crash," 1987

"Irrational exuberance" - Greenspan & Shiller

Bursting of "internet bubble" in 2000

Advanced popular notions that markets are plagued by irrationality, psychology of crowds, herding behavior

The Wisdom of Crowds (4)

Why It's Important (cont'd)

Questions posed by our lack of understanding of speculative markets

Can we trust markets? Behavioralist challenge: can we trust choices of individuals who don't fit the rational choice paradigm?

Yes.

Markets prices things, and these prices are informative

Market prices are hard to beat - even in markets where crazed fans back their favorite teams with money they "can't afford to lose."

F. von Hayek, "The Use of Knowledge in Society"

Knowledge is dispersed across time and space

Market prices are formed based on the aggregation of actions chosen by individuals, widely distributed

Market prices summarize relevant information

Result: prices coordinate better than central planning

Theory: Markets for Contingent Claims

Contingent claim: payment based on event

Examples:

Bonds: receive interest & principal

Stocks: dividends and capital gain

Horse Races: cash bet if horse finishes 1st

Point Spreads: cash if team "beats spread"

All of these markets are markets for contingent claims.

Theory of speculative prices applies to them all.

What's the big deal with horse races & point spreads?

Simple events - Galton's ox - reveal information aggregation more readily than complex ones - Challenger crash (even that was a one-off event).

Betting Markets & the Efficient Markets Hypothesis

An efficient market implies absence of profit opportunities

Equilibrium concept:

similar to law of one price

price of bread in Seneca and Clemson

price of IBM shares on Fridays & Mondays

in colloquial terms:

"money doesn't grow on trees"

"bookies aren't your personal ATM machine"

betting on the Mets or the Braves:

no profit opportunity betting on either

Why bother with betting and the EMH?

If EMH is true, odds in betting markets tell us something.

Odds contain information that is created by markets – we can use the markets to learn things that would otherwise be more difficult.

Implications of Efficient Pricing for Racetrack Betting

1. Parimutuel Odds (betting to win)

Notation:

W_i - amount bet on horse i to win the race

W - amount bet on all horses

$w_i = W_i/W = \% \text{ of wagering pool bet on horse } i$

$\text{Sum}(w_i) = 1$

$p_i = \text{probability that horse } i \text{ wins the race}$

$\text{Sum}(p_i) = 1$

Parimutuel Rules:

The pool is divided up among the winning bettors in proportion to the amount bet.

Assume zero takeout (W split among winning bettors)

Implications of Efficient Pricing for Racetrack Betting (2)

Example: only two people bet \$1 on horse #4 & it wins:
they split W equally (each gets $\$W/2$)

Add someone else who bets \$2 on horse #4; she gets $\frac{1}{2} W$;
1st 2 get $W/4$

General rule: return to \$1 bet on the winning horse is W/W_i

$R_i = W/W_i = 1/w_i$ is the return to betting \$1 of horse i

Implications of Efficient Pricing for Racetrack Betting (3)

2. Efficient Odds in the Betting Market

Mathematical Expected Return to betting \$1 on horse i:

$$ER_i = p_i R_i = p_i / w_i$$

ER_i , the expected return to betting \$1, is the probability of winning multiplied by the return to \$1 if horse i wins

It can also be thought of as how much one gets back for a \$1 bet on average, across a very large sample of bets

(i) The absence of profit opportunities implies that:

all horses must have expected returns = 1.0

(note this ignores the track's takeout, but doing so doesn't change the implications on this issue)

Implications of Efficient Pricing for Racetrack Betting (4)

(ii) Now suppose bettors care only about returns:

(colors, names, & jockeys are irrelevant; no "rooting interest")

this implies all horses must have the same expected returns

(iii) Together, these imply that $ER_i = 1.0$ for each horse

which further implies that $w_i = p_i$

A sharp result emerges: horse i 's share of the win pool is the probability it wins the race!

Evidence from Racetrack Betting

1. Hoerl and Fallin's study

studied all races run in New York City in 1969

results:

a) the odds predict the order of finish
favorites (higher w_i) are faster than longshots, on average

b) w_i is a remarkably good estimate of p_i (next table)

c) there is a slight tendency for favorites to be underbet
and longshots to be overbet (of 2nd order importance)

Mean Order of Finish By Odds Rank of Horse

No. of Entries	No. of Races	Ranking by Odds											
		1	2	3	4	5	6	7	8	9	10	11	12
5	69	2.1	2.4	2.9	3.4	4.1							
6	181	2.2	2.9	3.2	3.6	4.2	4.9						
7	312	2.8	3.2	3.7	4.0	4.3	4.6	5.4					
8	352	2.8	3.2	3.9	4.2	4.7	5.1	5.7	6.4				
9	283	3.1	3.6	4.1	4.6	5.1	5.3	6.0	6.4	7.1			
10	241	3.1	4.0	4.3	5.1	5.3	5.6	6.2	6.5	7.0	7.9		
11	154	3.8	4.0	4.7	5.2	5.7	5.8	6.3	6.9	7.2	7.8	8.5	
12	233	3.9	4.6	5.1	5.4	6.0	6.2	6.7	7.2	7.6	7.7	8.7	9.1

Source: Hoerl and Fallin (1974); data are from all 1,825 races run at Aqueduct and Belmont Park (NY) in 1970.

Comparison of Subjective Probabilities and Actual Winning Frequencies
By Odds Rank of Horse

No. of Entries	No. of Races		Ranking by Odds											
			1	2	3	4	5	6	7	8	9	10	11	12
5	69	Subj. prob.	.42	.25	.17	.11	.06							
		Obs. freq.	.41	.30	.20	.07	.03							
6	181	Subj. prob.	.36	.23	.17	.12	.08	.04						
		Obs. freq.	.43	.21	.20	.11	.03	.02						
7	312	Subj. prob.	.33	.22	.16	.12	.09	.06	.03					
		Obs. freq.	.34	.21	.16	.12	.08	.08	.02					
8	352	Subj. prob.	.31	.20	.15	.12	.09	.06	.04	.03				
		Obs. freq.	.33	.25	.13	.09	.07	.06	.04	.02				
9	283	Subj. prob.	.30	.20	.05	.11	.09	.06	.05	.03	.02			
		Obs. freq.	.35	.15	.17	.13	.08	.06	.02	.01	.02			
10	241	Subj. prob.	.29	.19	.14	.11	.08	.06	.05	.03	.02	.02		
		Obs. freq.	.31	.17	.16	.10	.07	.07	.06	.04	.02	.01		
11	154	Subj. prob.	.27	.18	.14	.11	.08	.07	.05	.04	.03	.02	.01	
		Obs. freq.	.27	.18	.19	.08	.05	.05	.05	.05	.04	.04	.01	
12	233	Subj. prob.	.26	.17	.13	.10	.08	.07	.05	.04	.03	.02	.02	.01
		Obs. freq.	.28	.14	.17	.12	.10	.06	.02	.05	.03	.03	.01	.00

Note: Subjective probability is the psychologists' term for w_i . The observed frequency data are the sample estimates of the probability of winning for horses of each odds rank in a field of N horses. Source: Hoerl and Fallin (1974); data are from all 1,825 races run at Aqueduct and Belmont Park (NY) in 1970.

2. Subsequent studies

the market beats the experts (wisdom of markets)

information from various sources is built into the odds that no single expert or model can account for

experts – handicappers, bookmakers, tipster – cannot beat the market day in, day out, in generating estimated probabilities of winning a horse races

See Sauer (1998) for a complete discussion

Other Markets

Today's (7/14/04) Odds & Implied Probabilities:
Apply the $ER = 1$ criterion to generate p from R

2004 Tour de France	Odds	Prob
Lance Armstrong	0.7	0.588
Jan Ulrich	4.55	0.180

2004 British Open	Odds	Prob
Tiger Woods	7.8	0.114
Ernie Els	7.9	0.112
Retief Goosen	15.8	0.060
Phil Mickelson	18.8	0.051
Sergio Garcia	19.5	0.049

Source: Betfair (midpoint of bid/ask offers)

How Much is a Pitcher Worth?

A starting pitcher works every fifth game.

Can such a player really be worth \$10-\$15m / year?

Sauer-style (off-beat) approach:

Use *betting markets* to ascertain impact of pitchers on team's chance of winning a game

Use the absence of profit opportunities condition:

$$ER = \text{prob of winning} * \text{return to \$1 bet} = \$1$$

Atlanta vs NY Mets (summer 2003): Maddux vs. Trachsel

Returns to \$1 bet

ATL: \$1.49

NY: \$2.85

Efficiency implies (using strict equality)

$$p(\text{ATL}) * \$1.49 = 1 \quad p(\text{ATL}) = .6711$$

$$p(\text{NY}) * 2.85 = 1 \quad p(\text{NY}) = .3509$$

Sum = 1.022 but true probabilities must sum to 1.0!

The sum > 1 since bookmaker requires $ER < 1$ to stay in business (the .022 is called the bookies' vigorish).

Correction: divide each initial p by 1.022:

$$p'(\text{ATL}) = .6567$$

$$p'(\text{NY}) = .3433$$

How Much is a Pitcher Worth (2)?

What does EMH tell us?

In this case, the probability each team wins the game.

But markets exist for 30 teams, 162 games each year.

Odds for each game differ based on the starting pitchers.

When good pitchers start, the market's assessment of the incremental value of the pitcher is factored into the odds; similarly for not-so-good pitchers.

This variation can be exploited using statistical techniques to obtain the market's estimate of the value of star pitchers.

How Much is a Pitcher Worth (3)?

In current research, I've estimated (with colleagues) the impact on the probability of winning of adding star pitchers to a typical team.

The results: top pitchers add .17 (Maddux) to .22 (Pedro Martinez) in probability to an average lineup's chances of winning a game.

This is an enormous amount, and dwarfs the impact of ANY position player on the outcome of a game.

The expected # of *additional* wins for a .20 pitcher with 30 starts per season is thus: $.20 * 30 = 6$ games.

This implies that, basically on his own, a star MLB pitcher adds 6 wins to his team's total (over a typical pitcher). For the average team that wins 81 games, this about 7.5% of games won.

By these estimates, a star pitcher's skill makes a significant contribution to winning, and would merit a significant share of the revenues generated by winning.

Final Note

There is a difference between the "wisdom of crowds" and the "wisdom of markets."

Both create information by aggregating the opinions of many people.

A simple average of the opinions of Surowiecki's "crowd" is unweighted. The uninformed get the same weight as those with more knowledge.

Markets weight the opinions differently: self-interested, motivated behavior by investors, bettors, or traders in general will generally lead to more weight being placed on the opinions of those with more information.

As a result, information created by a market is more accurate than information created by merely sampling the opinion of a crowd.

References

Brown, William O. and Sauer, Raymond D. "Fundamentals or Noise? Evidence from the Point Spread Betting Market," *Journal of Finance*, September 1993, 48(4), pp. 1193-1209.

von Hayek, Friedrich A. "The Use of Knowledge in Society," *American Economic Review*, 1945, v. 35, 519-30.

Hoerl, Arthur E. and Fallin, Herbert K. "Reliability of Subjective Evaluations in a High Incentive Situation," *Journal of the Royal Statistical Society A*, 1974, 137, pp. 227-230.

Sauer, Raymond D. "The Economics of Wagering Markets," *Journal of Economic Literature*, December 1998.

Surowiecki, James. *The Wisdom of Crowds: Why the Many Are Smarter than the Few and How Collective Wisdom Shapes Business, Economies, Societies, and Nations*, Doubleday: New York, 2004.