DECISION MARKETS, STRONG-FORM EFFICIENCY, AND “UNCANNILY ACCURATE” PREDICTIONS

Russ Ray, University of Louisville

MODELING DECISION MARKETS

Plott (2000) first modeled decision markets within the classical context of “rational expectations.” (For an overview of the theory of rational expectations, see Young and Darity (2001). Although decision markets have never been modeled within the context of efficient-markets, they can be easily so modeled:
$E_m(\rho_{j,t}) = (P_{j,t} \mid \theta_t)$
where

- E_m = the market's expectation;
- $\rho_{j,t}$ = the probability, at time t, of claim j being realized;
- $P_{j,t}$ = the price of claim j at time t; and,
- θ_t = the information set utilized by the market at time t to form its expectation.

In a decision market, θ_t contains both public information and *inside* information, thereby making the market efficient in the strong form of the theory, by definition.

Given the “uncannily accurate” ability of decision markets to forecast the future, a forecasting model of these markets would be highly valuable to managers, hedgers, speculators, regulators, policy makers, and others who could utilize the predictions in decision markets for their respective purposes.

One method would be to simply define a probability of, say, .75 (or higher) to be significantly greater than random chance, and to define a probability of, say, .25 (or smaller) to be significantly less than random chance.

A more exact method would be to use a statistical tool such as a test for the difference between two means. To derive such a measure, define

$$\mu_{t+n} = \rho_{j,t+n} - .5; \quad n = 0, 1, 2, 3, \ldots$$

so that μ is the probability distribution of deviations from random chance (i.e., $\rho = .5$), having mean $\bar{\mu}_t$ and standard deviation σ_μ. Any reasonable assumption regarding the first two moments of the distribution of a given claim would generate a mean and standard deviation for the distribution so that with two means ($\bar{\mu}_t$ and .5) and two standard deviations, the difference between two means could easily be tested. Such a test would ascertain when a given claim/forecast was significantly greater or less than a forecast of random chance. A software program could easily monitor any decision market and continually perform tests for the difference between two means, alerting decision makers when such differences are statistically significant.

The least restrictive assumption regarding the distribution of claims (and, thus, the most powerful decision rule) is the assumption that claims in a decision market can follow *any* distribution. The decision rule in this case can be derived by using Chebyshev’s Inequality (which is “distribution free” and applies to all probability distributions, regardless of the values of any of their moments). (For readers unfamiliar with Chebyshev's Inequality, see any comprehensive textbook in statistics; for example, see Shiffler and Adams (1990).)

To derive a distribution-free decision rule, define ψ to be

$$\psi_t = \mu_t - \bar{\mu}_t$$

where μ_t and $\bar{\mu}_t$ are defined as above. Let π be the probability distribution of ψ. In accordance with Chebyshev's Inequality:

$$\pi(\psi \geq K_{\sigma_\mu}) \leq (K^2)^{-1}$$

where $K = \sqrt{2}$ so that $(K^2)^{-1} = .5$, i.e., random chance.

Finally, define π^* to be any probability that is significantly less or significantly greater than random chance. Expanding Chebyshev's Inequality above,

$$\bar{\mu}_t - \sqrt{2}\ \sigma_\mu \geq \pi_t^* \geq \bar{\mu}_t + \sqrt{2}\ \sigma_\mu$$

and values of π^* so derived represent probabilities significantly less and significantly greater than random chance, respectively. Forecasts so derived could offer considerable utility to managers, hedgers, speculators, regulators, policy makers, and others who routinely rely upon forecasts in order to make their respective decisions.

(Note: The above application of Chebyshev's Inequality – to determine when a probability is significantly different than random chance – was created by the author and used in his dissertation at the University of Michigan, Ann Arbor. The dissertation has purposefully not been cited in the bibliography of this paper in order to preserve author anonymity for the reviewer.)

SUMMARY AND CONCLUSION

Decision markets are an interesting anomaly. Operating in cyberspace and completely unregulated, these markets are arguably the most efficient markets in all of history. Unlike regulated markets, decision markets thrive on inside information.

A large body of anecdotal evidence, as well as a smaller body of statistical evidence, has found that the predictions in these markets have proven to be "uncannily accurate" forecasts of the future, including the financial future. Decision rules can be derived to identify which forecasts are significantly different from those predicted by random chance. Forecasts so identified could offer considerable managerial, economic, social, and political utility.

REFERENCES

[1] Ball, R. (1995). "The Theory of Stock Market Efficiency: Accomplishments and Limitations." *Journal of Applied Corporate Finance,* 8(1), 4-17.

[2] Berg, J., and Rietz, T. (2003). "Prediction Markets as Decision Support Systems." *Information Systems Frontiers*, 5(1), 79-93.

[3] Berg, J., Nelson, F., and Rietz, T. (2001). “Accuracy and Forecast Standard Error of Prediction Markets.” *University of Iowa Working Paper*.

[4] Debus, A. (1970). *Science and Education in the Seventeenth Century*. London: MacDonald Press.

[5] Dobbs, L. (August 11, 2003). “Deep Six-ing a Bright Idea.” *U.S. News & World Report.*

[6] Fama, E. (1998). “Market Efficiency, Long Term Returns, and Behavioral Finance.” *Journal of Financial Economics,* 49(3), 283-306.

[7] Forsythe, R., Nelson, F., Neumann, G., and Wright, J. (1992). “Anatomy of an Experimental Political Stock Market.” *American Economic Review*, 82, 1142-1161.

[8] Forsythe, R., and Lundholm, R. (1990). “Information Aggregation in an Experimental Market.” *Econometrica*, 58(2), 309-347.

[9] Hanson, R. (1999). “Decision Markets.” *IEEE Intelligent Systems*, 14(3), 16-19.

[10] Hanson, R. (1990). “Could Gambling Save Science? Engineering an Honest Consensus.” *Proceedings, 8th International Conference on Risk and Gambling.* London. (Reprinted in (1995) *Social Epistemology*, 9(1), 3-33.)

[11] Hull, J. (2002). *Fundamentals of Futures and Options,* 4th ed. New Jersey: Prentice Hall.

[12] Kiviat, B. (2004). “The End of Management?” *Time Magazine*. July 12.

[13] Malkiel, B. (2003). “The Efficient Market Hypothesis and its Critics.” *Journal of Economic Perspectives*, 17(1), 59-82.

[14] Pennock, S., Lawrence, C., Giles, L. and Nielsen, F. (2001). “The Real Power of Artificial Markets.” *Science*. 291(5506), 987-988.

[15] Pethokoukis, J. (2004). “All Seeing, All Knowing.” *U.S. News & World Report.* Aug. 30,

[16] Plott, C. (2000). “Markets as Information Gathering Tools.” *Southern Economic Journal*, 67, 2-15.

[17] Ray, R. (1996). “Idea Futures: A Free-Market Approach to Academic Research.” *Futures Research Quarterly*, 12(2), 81-91.

[18] Servan-Schreiber, e., Wolfers, J., Pennock, D., and Galebach, B. (2004). “Prediction Markets: Does Money Matter?” *Electronic Markets,* 14(3).

[19] Shiffler, R., and Adams, A. *Introductory Business Statistics.* Boston: PWS-Kent Publishing Company, 1990.

[20] Shiller, R. (2003). “ From Efficient Markets Theory to Behavioral Finance.” *Journal of Economic Perspectives,* 17(1), 83-104.

[21] Stoll, H. (1989). “ Inferring the Components of the Bid-ask Spread: Theory and Empirical Tests.” *Journal of Finance*, 44(1), 115-134.

[22] Surowiecki, J. (2003). “Decisions, Decisions.” *The NewYorker*. March 24,

[23] Surowiecki, J. (2004). *The Wisdon of Crowds.* New York: Doubleday.

[24] Wolfers, J., and Zitzewitz, E. (2004). “Prediction Markets.” Working Paper No. 10504. U.S. National Bureau of Economic Research.

[25] Young, W., and Darity, W. (2001). “The Early History of Rational and Implicit Expectations.” *History of Political Economy*, 33(4), 773-813.