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Prediction Markets and Risk Management

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Outline

- Introduction
  - What are global risks?
  - What are prediction markets?
  - How do they work?
- Properties of prediction markets
  - Accuracy
  - Returns
- Uses in risk assessment and management
  - Identification
  - Measurement
  - Management
    - Hedging
    - Resource Allocation
- Concluding Remarks
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  - Weaknesses
  - The key issue: Contract design
- Appendix
  - Some prediction markets of interest for risk assessment and management

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Introduction

What are Risks?

- "Global Risks" 2007, Global Risk Network Report identifies:
  - Economic
  - Environmental
  - Geopolitical
  - Societal
  - Technological

What Are Prediction Markets?

- Futures and options markets with
  - Payoffs tied to events of interest
  - Designed specifically to
    - Aggregate information and
    - Forecast
- Example: The Iowa Electronic Markets (IEM)
  - www.biz.uiowa.edu/iem

2008 IEM Presidential Markets

- Tied to Election Outcomes
- "Vote-Share" Market
  - UDEM08_VS
    - Pays $1 x Democratic % of 2-party vote
  - UREP08_VS
    - Pays $1 x Republican % of 2-party vote
- "Winner-Takes-All" (Binary Option) Market
  - DEM08_WTA
    - Pays $1 if Democratic % of 2-party vote > 50%
  - REP08_WTA
    - Pays $1 if Republican % of 2-party vote > 50%

How do Prediction Markets Work? Mechanics

- Traders
  - Open account and
  - Place orders through the internet
- Exchange
  - Accepts orders in a time and price ordered queues
  - Clears trades when orders cross or are accepted
- IEM allows traders to create contracts
  - Unit portfolios (1 of each contract) can be purchased from or sold to exchange at any time

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How do Prediction Markets Work? Theory: Re-Insurance Pricing

- Borch K.
  - "The Safety Loading of Reinsurance Premiums," Skandinavisk Aktuarietidskrift, XLIII, 163-184, 1960.
- Contingent claim prices reflect
  1. Relative state probabilities and
  2. Relative endowments in states
- Unit portfolios → constant endowments
  - → Contingent claim prices ONLY reflect state probabilities
  - → Prices = Expected Values!

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How do Prediction Markets Work? Theory: Modern Option Pricing

- Brealey, Myers and Allen, 8th Ed., pg. 568

$$\Pr(Dem) = \frac{r-(-1)}{\frac{1-P_{Dem}}{P_{Dem}}-(-1)} = (1+r)P_{Dem} \Rightarrow P_{Dem} = \frac{\Pr(Dem)}{(1+r)}$$

- Unit portfolio → $1 = \frac{\Pr(Rep)}{(1+r)} + \frac{\Pr(Dem)}{(1+r)} \Rightarrow r = 0$

→ P_{Dem} = Pr(Dem); P_{Rep} = Pr(Rep)

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How do Prediction Markets Work? Practice

- **Current laboratory and field work suggests the following avenues:**
  - **Information sharing**
  - **Information aggregation**
  - **Information production**
  - **Dynamic feedback**
  - **Trader self-selection**
  - **Trader role selection**

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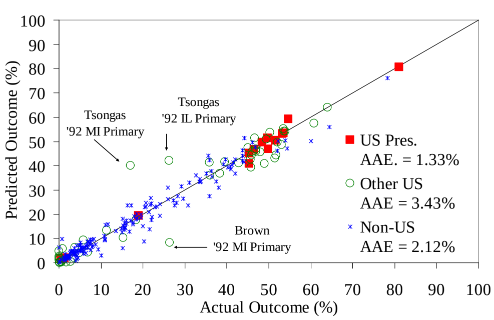
Properties of Prediction Markets

IEM Vote Share Accuracy



Source: Berg & Rietz, "The Iowa Electronic Market: Stylized Facts and Open Issues." In Information Markets: A New Way of Making Decisions in the Public and Private Sectors. Tetlock & Litan (eds.). AEI-Brookings Joint Center, Washington, D.C., 2006

IEM Vote Share Accuracy

Days included in sample	Item	1988	1992	1996	2000	2004	all years
Overall	Number of polls	59	151	157	229	368	964
	market "wins"	34	108	136	173	258	709
	% market	58%	72%	87%	76%	70%	74%
> 100 Days in Advance	Number of polls	14	69	33	49	195	360
	market "wins"	13	49	30	47	129	268
	% market	93%	71%	91%	96%	66%	74%

- **Returns appear to follow efficient (Bayesian) random walk**

Sources:
Berg, Nelson & Rietz, "Accuracy and Forecast Standard Error of Prediction Markets." Working Paper, July 2003, www.biz.uiowa.edu/faculty/trietz
Berg, Nelson & Rietz, "Prediction Market Accuracy in the Long Run," Working Paper, Jun3 2007.

IEM WTA Price Dynamics

Content removed because of journal publishing requirements

Source: Majumder, Diermeier, Rietz & Amaral, "Price Dynamics in Prediction Markets," Working Paper, May 2007

IEM WTA Price Dynamics: Modified Binomial Tree

Content removed because of journal publishing requirements

Source: Majumder, Diermeier, Rietz & Amaral, "Price Dynamics in Prediction Markets," Working Paper, May 2007

IEM WTA Price Dynamics: Modified Binomial Tree

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Uses in Risk Assessment and Management

Uses in Risk Assessment and Management

- **Assessment**
  - **Assessment of known risks**
  - **Identification of unknown risks**
    - **"Other" contracts**
    - **Trader proposed contracts**
- **Management**
  - **Hedging**
  - **Resource Allocation**

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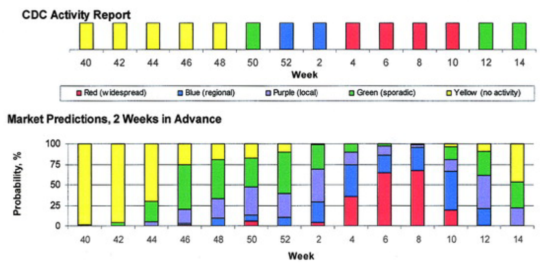
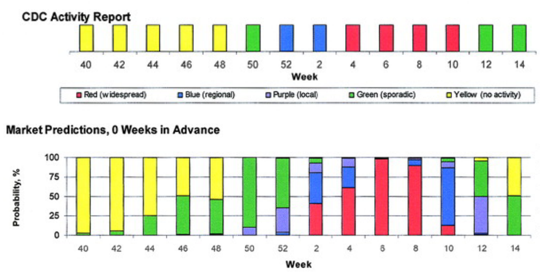
Assessment Example: Influenza Markets



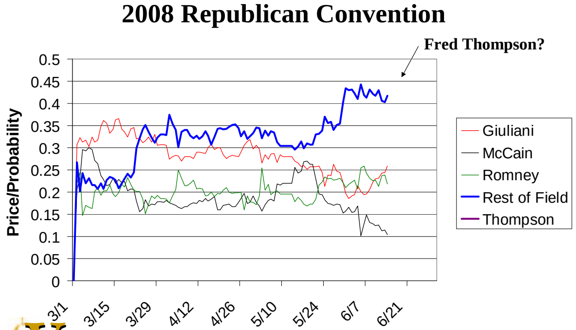
Source: Polgreen, Nelson & Neumann, "Use of Prediction Markets to Forecast Infectious Disease Activity," Clinical Infectious Diseases 2007, Jan 15;44(2):272-9.

Assessment Example: Influenza Markets



Source: Polgreen, Nelson & Neumann, "Use of Prediction Markets to Forecast Infectious Disease Activity," Clinical Infectious Diseases 2007, Jan 15;44(2):272-9.

Identification of Unknown Risks: 2008 Republican Convention



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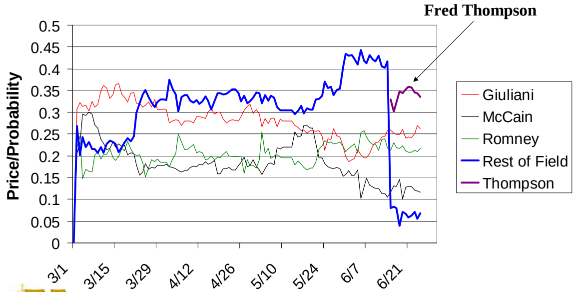
Source: Data from www.biz.uiowa.edu/iem

Identification of Unknown Risks: 2008 Republican Convention



Source: Data from www.biz.uiowa.edu/iem

Identification of Unknown Risks: Trader Proposed Contracts

- **Forsight Exchange**
  - **www.ideosphere.com**
  - **Traders propose and judge contracts**
- **DARPA**
  - **Proposal for traders to propose contracts**
- **Some corporate interest**

Hedging Example Chicago Mercantile Exchange

- **Heating Degree Days**
- **Cooling Degree Days**
- **Cumulative Average Temperature**
- **Frost Days**
- **Snowfall**
- **Hurricane**
  - **Landfall x Carvill Hurricane Index**

Note: IEM in in its third year of trading small scale Hurricane markets

Resource Allocation Example: IEM Influenza markets

- 2 weeks warning is enough time to:
  - Reschedule elective surgeries
  - Ship saline
  - Cancel vacations and leaves of medical personnel
  - Recommend alternative work arrangements and other preventive measures

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Concluding Remarks

Strengths

- Anonymity
- Allows a common language
- Incentives for Information Production
- True information AGGREGATION
- Speed
- Flexible Design

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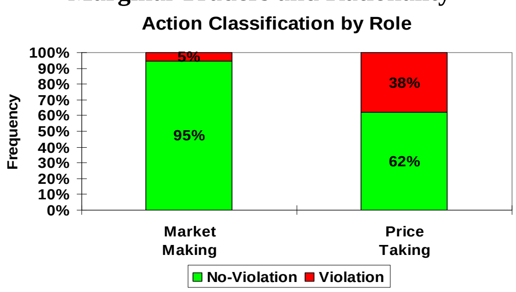
Weaknesses

- Legal issues
- Public relations issues
- Information issues
- Manipulation(?)
- Trader Heuristics and Biases
- Self invalidation

What About Trader Biases and Heuristics? Marginal Traders and Rationality



Source: Oliven & Rietz, 2004, "Suckers are Born, but Markets are Made: Individual Rationality, Arbitrage and Market Efficiency on an Electronic Futures Market," Management Science, 50:3, 336-351, March 2004.

An Issue: Self-Invalidation Example from "Company X"

- Two processes "A" and "B" create vulnerabilities for Company X
- Company X want to assess relative likelihood of loss from the two vulnerabilities
- Contracts:
  - "ALoss" will pay $1 if loss occurs from process A first
  - "BLoss" will pay $1 if loss occurs from process B first
- Company X will devote loss prevention resources based on this market

An Issue: Self-Invalidation Example from "Company X"

- The contracts are self-invalidating
- Why?
- What is the outcome?
- How could they fix this problem?
  - A: Conditional Contracts
    - Run loss contracts conditional on allocation of resources across A and B
- For conditional contract description and uses see:
  - Berg & Rietz, 2003, "Prediction Markets As Decision Support Systems," Information Systems Frontiers, 5:1, 79-93.

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The KEY Issue: Contract Design

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For more information:

IEM: www.biz.uiowa.edu/iem

Vaughan Institute: http://www.biz.uiowa.edu/insurance/

Personal Webpage: http://www.biz.uiowa.edu/faculty/trietz/

E-mail: Thomas-Rietz@uiowa.edu

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TIPPIE

Appendix

Some Prediction Markets of Interest for Global Risk Assessment and Management

Some Prediction Markets and Markets with Prediction Style Contracts

- Iowa Electronic Markets
  - www.biz.uiowa.edu/iem
- Hedge Street
  - www.hedgestreet.com
- Chicago Board of Trade
  - www.cbot.com
- Chicago Mercantile Exchange
  - www.cme.com
- InTrade
  - www.intrade.com
- Cantor Fitzgerald / Hollywood Stock Exchange
  - http://www.hsx.com/
- ForeSight Exchange
  - www.ideosphere,com

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Markets of Interest: Core Global Economic Risks

- IEM
  - Federal Funds Rates
  - Has rights to economic indicator markets
  - In the past ran on unemployment and inflation
  - Proposed: Run on "misery" index.
- Chicago Board of Trade
  - Federal Funds Rates
- HedgeStreet
  - Federal Funds Rates
  - CPI
  - Crude Oil and Natural Gas
  - Housing Prices
- InTrade and Foresight Exchange
  - Range of contracts
- Financial outcomes well covered by "regular" financial markets

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Markets of Interest: Core Global Environmental Risks

- IEM
  - Hurricane Landfall
  - Proposed: EPA global warming market
- Foresight Exchange
  - Big West Coast quake by 2010
  - Atlantic tropical storms
  - CO2 level 2030
- InTrade
  - Hurricane
  - Global warming
- Chicago Mercantile Exchange:
  - Event (Landfall) Markets based on Carvill Hurricane Index (CHI)
  - Heating/Cooling Degree Days
  - Cumulative Average Temperature
  - Snowfall and Frost

Markets of Interest: Core Global Geopolitical Risks

- DARPA
  - “Terrorism” Markets
  - Outcomes of strategies
- InTrade
  - US/Israeli air strike against Iran
  - US Military action against Korea
  - EU act of terror before 2010

Markets of Interest: Core Global Societal Risks

- IEM Health Markets
  - Influenza, Mumps and Avian Flu
- Foresight exchange
  - Smallpox returns<2010
  - flu-pandemic before 2010
  - Cancer cured by 2010
  - Eventual Collapse of Universe
- Intrade
  - Bird Flu

Markets of Interest:
Core Global Technological Risks

- **Foresight Exchange**
  - **Numerous technological markets**
- **InTrade**
  - **Numerous technological markets**